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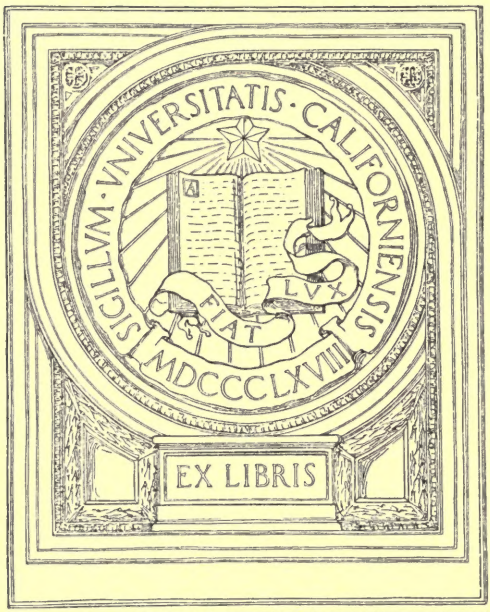

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MANUAL OF PHYSIO-THERAPEUTICS

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MANUAL OF PHYSIO-THERAPEUTICS

BY

THOMAS DAVEY LUKE

M.D., F.R.C.S. Ed.

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SOMETIME LECTURER AT THE EDINBURGH UNIVERSITY;
AUTHOR OF "SPAS AND BRITISH HEALTH RESORTS," ETC., ETC.

WITH MANY ILLUSTRATIONS

NEW AND REVISED EDITION

"Would you have us place reliance
Less in drugs and pseudo science?
More in Nature; for our ills
Using sense and fewer Pills?
No—the change were all too tragic.
Most folks like being healed by Magic."

ANON.

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Dedicated to

SIR HUMPHRY DAVY ROLLESTON,

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CONSULTING PHYSICIAN, ST. GEORGE'S HOSPITAL, W.;
LATELY SURGEON REAR-ADMIRAL, R.N.,

WITH PLEASANT MEMORIES OF ASSOCIATED WORK
IN THE GREAT WAR

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PREFACE

Some twelve years have elapsed since the first edition of this work was passing through the press, and during that time enormous strides have taken place in physio-therapeutics. The scope of treatment at our leading spas has greatly widened, and on the whole the drinking of mineral waters—some with a very nasty taste!—now takes second place to bathing and douching and the various other methods of physical treatment.

In all departments of medicine the experience of the war has caused a great advance, but in no section has it been greater than in physio-therapeutics. Treatment stations established throughout the country for the cure of the wounded are now continued for the further treatment of ex-soldiers under the Ministry of Pensions. Massage, electricity, and the other methods associated with them, have ceased to be the monopoly of the idle rich and valetudinarian; their value is recognized by the working classes and has been demonstrated to them not once, but on many thousands of occasions.

The author was highly gratified by the favourable reception afforded this work when it first appeared, but is now confident that there is a much larger field for it and a larger circle of readers. Several sections have been entirely rewritten, all have been brought up to date, and an entirely new one added on physical training based on the Bruce Sutherland system. The author would here express his cordial thanks to Mr. Bruce Sutherland for his great help in

this matter, and the loan of many most excellent figures which most effectively illustrate the text; and also to Messrs. T. Nelson and Son, his publishers.

My thanks further are due to Mr. A. Dickson for valuable help on technical points in the electrical section, and many good suggestions.

T. D. LUKE.

Emsworth House,
Clevedon,
January, 1922.

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MANUAL OF
PHYSIO-THERAPEUTICS

SECTION I
THERMOTHERAPY

CHAPTER I
GENERAL PRINCIPLES

The use of heat, in one form or other, in therapeutics dates back to the dim and distant ages of remotest antiquity; even animals, when ill, instinctively have recourse to the radiant heat of the sun. Doubtless the first idea of the use of heat as a curative agent arose from the beneficial effects experienced from submitting the body to the influence of the solar rays.

The therapeutical applications of heat are innumerable, and, with the progress of science, have gradually extended their range from the linseed poultice of former times to the modern and elegant appliances for treatment by means of moist or dry heat; from the old Roman sweating-houses to the luxurious and well-appointed Turkish baths of the present day.

Although originally practised by enthusiasts on more or less empiric lines—in common with many other forms of treatment which have subsequently received the warm approval of medical men and scientists—the use of heat in its various forms has during the last century been the subject of study by numerous medical men throughout the world.

In 1840, Guyot issued his "Traité de l'Incubation," the first serious study on hot air and the employment of high temperatures for the alleviation of pain, especially with reference to affections of the bones.

In 1844, Chautard, perceiving the value attaching to luminous radiant heat, strongly recommended its adoption in treating rheumatism.

Heat may be employed in three different forms: 1. Moist heat. 2. Dry heat. 3. Luminous radiant heat.

1. **Moist Heat.**—Without going into the question of ordinary baths, poultices, fomentations, etc., we will now consider what takes place in vapour baths, of which the temperature varies from 24° C. to 49° C. The enclosure within which such baths are given consists of a closed chamber into which is allowed to flow either pure water vapour or vapour charged with medicinal substances. The patient usually bears without inconvenience a temperature of from 24° C. to 44° C., but beyond this latter temperature and up to, say, 50° C., the respiration and circulation are very noticeably accelerated, and such untoward events as vertigo, loss of consciousness, congestion, hæmorrhage, etc., are to be feared. These are due to the hot vapour, which renders respiration laborious and painful, and also to the obstruction offered to the evaporation of the moisture given off from the body in an atmosphere already supersaturated with moisture. In order to get rid of the first of these difficulties, there has been introduced the box bath, which consists of an enclosure within which only the body is enveloped in vapour, the head being outside the box, thus permitting the lungs to receive air from without. In spite of this, when one enters a room in which such box baths are being given, the high temperature is generally very noticeable, as are also the humidity and disagreeable odour of the atmosphere which one breathes. It is practically impossible to remedy the difficulty of evaporation of the perspiration.

2. **Dry Heat.**—Among the applications of dry heat in which air does not play the part of the conducting medium, and in which the temperature does not get beyond 49° C. to 55° C., are bran, salt, or hot sand compresses, dry fomentations, etc.

The hot-air bath represents the more general application of dry heat; the temperature varies from 40° C. to 74° C., and may even reach 112° C., the maximum temperature

bearable for any length of time; but it is not prudent to submit patients to this latter temperature.

In 1893 Tallerman demonstrated the possibility of attaining with dry heat temperatures unknown until then. His apparatus consists of a metal cylinder heated by numerous gas jets. The cylinder is closed at one end, with the exception of one small opening where a ventilator is fixed. At the other end is fixed a movable screen of special cloth, with an opening in the centre through which the affected limb is passed. The apparatus thus consists of a closed space with a means of securing ventilation. Considerable experience in English and American hospitals demonstrates that a temperature of 148° C. can be borne without inconvenience, and gives good therapeutic results in some cases. The apparatus was to all intents and purposes *a gas oven*, and products of combustion are distinctly perceptible.

3. **Luminous Radiant Heat.**—This is either natural or artificial: natural in sun baths; artificial in the Dowsing baths. The latter system of baths possesses many and considerable advantages over all other systems, and permits of a temperature of upwards of 260° C. being attained, and maintained with safety.

In order to fully appreciate the medical value of luminous radiant heat, it is necessary to explain here certain of its physical properties which are but little understood at the present day.

Some Physical Facts in regard to Luminous Radiant Heat.

Luminous radiant heat—of which the sun represents the best possible example—is the conjunction of radiant heat with light and certain chemical rays. All combustion with flame creates luminous radiant heat, but it is not always necessary to use combustion, in the chemical sense of the word, to obtain this mode of transformation of energy. Electricity can transform itself directly, *in vacuo*, into luminous radiant heat. This is the case with the Dowsing lamp, which emits simultaneously heat rays and light rays (see Fig. 1).

Radiant heat, light rays, and chemical rays are three types of radiant energy; from the physical point of view there is no essential difference between them, and their laws of propagation are identical.

Radiant heat is that which, emanating from a heated body, passes through other bodies, described as diathermanous, as light passes through diaphanous bodies.

A part of the sun's heat travels through the atmosphere as light, without being absorbed in it; the fire from the

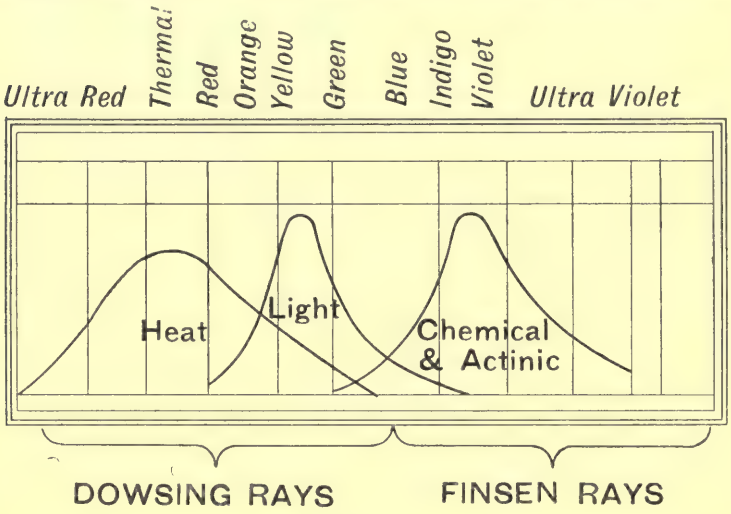


FIG. 1.

hearth warms us at a distance without the heat which it emits being absorbed by the air which separates it from us. This is what is known as *radiation.*

Radiation consists in the vibrations of ether produced by the impulse of molecular movements of a radiant body. Luminous rays are perceptible to us by the eyes, and heat rays by the skin and flesh: but the invisible rays of heat, the luminous rays of light, and the chemical rays are each represented by ether vibrations, only distinguishable by difference in length of wave. Tyndall demonstrated this in his studies on the spectrum; in fact, when we observe the obscure region of the spectrum, we see that the heat rays become more and more intense in proportion to the

proximity of the luminous rays; at the same time the heat waves acquire a greater amplitude, causing greater energy of vibration, the energy of vibration being proportional to the square of the amplitude. Thus, to obtain high temperatures, a source of luminous heat is preferable to all others.

In spite of the identity in origin of obscure and luminous heat, it is not less true that luminous heat possesses properties peculiar to itself.

Practically, the transmission of obscure heat is effected by convection, and consequently indicates the raising of the temperature of the surrounding atmosphere; for example, to raise by, for instance, 30° the temperature of a body separated some distance from a source of obscure heat, it is absolutely necessary that the atmosphere of the intervening space be also raised by 30°.

Luminous radiant heat will effect its purpose without raising the temperature of the surrounding atmosphere; its rays, like the rays of the sun, do not by convection carry the heat from point to point, but merely energy in the shape of vibrations, which energy is transformed, or converted, into effective heat in encountering obstructing bodies.

Luminous radiant heat may be diffused as light, and reflected and directed by means of suitably arranged reflectors. This may be readily demonstrated by arranging opposite each other, some little distance apart, two large spherical or parabolic mirrors of burnished copper in such a manner that their axes are coincident, and placing a piece of live coal or other lighted substance in front of the one, and a piece of tinder in front of the other, when it will be found that the tinder almost immediately bursts into flame.

Luminous rays and chemical rays play an important part in radiant heat, and it may be useful at this point to mention some features of special interest. Under certain conditions, light becomes converted into heat. A striking example of this is shown in connection with a conservatory. If, when the sun is shining brightly, all ventilation is stopped for a few hours, the heat within the conservatory becomes intolerable. The heat rays alone are not responsible for this increase in temperature, for, as is well known, heat rays

only penetrate through glass to the extent of 33 per cent., a percentage quite insufficient to account for the rapid rise in temperature within the conservatory. The explanation is to be found in the fact that the luminous rays, which pass through glass practically without diminution, coming into contact with the plants and other objects within the conservatory, are absorbed in such subjects, and thus converted into effective heat. Tyndall has demonstrated the same thing by the following ingenious experiment. He passed a beam of electric light through water to absorb the heat rays, and then, by passing the resultant rays through a lens of ice, he set fire to some black paper and ignited gun-cotton on the other side, showing that it was not the heat rays which brought about that result, but the light rays. In other words, the wave lengths were altered, they were lowered in refrangibility, and converted into heat.

Certain substances, amongst others platinocyanide of barium, have the property of absorbing rays of a certain wave length and of emitting rays, more or less luminous, of a different wave length. This interesting phenomenon constitutes fluorescences, of which the radioscope represents the most important application.

Thus we see that luminous radiant heat is formed by the blending together of heat rays, luminous rays, and chemical rays; but it is possible to eliminate either one or other, and to have separately either heat rays, light rays, or chemical rays.

In order to separate heat rays from luminous rays, we utilize the fundamental difference between their action on the bodies they meet. Amongst such bodies, some completely stop the passage of radiant heat, and for this reason are called athermanous; others, which permit the passage of radiant heat, are called diathermanous. Diathermanous bodies are not necessarily transparent, nor are athermanous ones necessarily opaque. An alum solution allows the light to pass through, but completely stops the passage of heat. Iodine, on the other hand, in solution of bisulphide of carbon, allows the invisible heat rays to pass, but effectively obstructs the light rays. These facts are easily demonstrated. Water will boil by light which

has passed through iodine and is concentrated in a glass tube containing water. If the iodine is replaced by an alum solution, the boiling ceases instantly.

Summarizing briefly, it may be stated that:

1. Luminous radiant heat is made up of different radiations or vibrations, which can be separated one from the other.
2. It can be directed on to a body without raising the temperature of the surrounding atmosphere.
3. It can penetrate glass without diminution of potency.
4. It can be reflected by means of reflectors.
5. It can be so diffused by means of special appliances that very high temperatures may be attained by the air enclosed in a given space.

The **Physiological Action** of luminous radiant heat, which is composed of heat, light, and chemical rays, each possessing specific and important properties, is determined by the combined action of all such rays upon the body. This, from the therapeutic point of view, is of much interest, as it is such a combination of rays which in practice is most often brought into requisition.

One remarkable feature at once attracts attention. The human body can bear, with luminous radiant heat, much higher temperatures than have hitherto proved possible by any other application of heat. The complete or whole body bath can be used without danger at a temperature of upwards of 200° C.; this bath is usually given with a temperature ranging approximately from 149° to 205° C., while with the local bath a temperature of upwards of 260° C. may be attained.

At first sight it would naturally be thought that such high temperatures must necessarily be productive of considerable risk to the human organism. In hot-air (Turkish) baths the temperature rarely rises beyond 79° C. Cutaneous perspiration and respiration are the only means at the disposal of the body for maintaining its temperature under such conditions. This remains equally true when using the Dowsing system, with this very important difference, that the action of the skin and lungs can be raised to the

highest possible pitch, because the respiration of the patient is not affected, the air inhaled being of the normal temperature. Cutaneous perspiration is an example of the well-known fact that water cannot be converted into vapour without absorbing and rendering latent a considerable amount of heat. The quantity of water, in the form of vapour, exhaled by the human body has been estimated at 32 ounces per diem. The heat absorbed and rendered latent by such evaporation is, according to the most careful calculations, equal to that which would raise the same weight of water from 0° to 625° C.

Cutaneous perspiration can thus be considered a most powerful agent in regulating the temperature of the human body, and observation demonstrates that it becomes more active, and therefore absorbs more heat, as the temperature around it is raised. But in order to attain this result it is essential that the air in contact with the skin be kept free from moisture, the presence of which tends to the reduction of the perspiration, and in fact stops it entirely when the atmosphere becomes supersaturated. To ensure the requisite dryness of air, it is therefore essential that some more or less perfect system of ventilation should be obtained. It is for this reason that the ordinary hot-air bath, having no appreciable ventilation, may become a source of no little danger to the patient.

The evaporation which takes place in the pulmonary cavities constitutes a further means which the body possesses for maintaining its proper temperature in a superheated atmosphere. Its intensity is in inverse ratio to the moist condition of the air.

To undergo high temperatures, it is essential that the temperature of the body should remain normal. To accomplish this, the heat which is given off must be almost entirely converted into another form of energy—viz., the latent heat of vapour.

The Dowsing appliances, utilizing luminous radiant heat by direct radiation without heating the surrounding atmosphere, do not increase the temperature of a room, and in no way affect the breathing of the patient; and by diffusing the heat in a confined space automatically

ventilated the same results follow. The constant renewal of the air in contact with the body of the patient, securing freedom from saturation, enables temperatures hitherto unknown to be obtained by the use of luminous radiant heat.

Remarkable potency and uniformity are characteristics of the physiological action of these high temperatures, which have been closely studied by, amongst others, Hedley and Douglas Kerr, of Bath. The results obtained by them, which are very similar to those given by Chrétien, of the Salpêtrière Hospital, may briefly be stated as follows:

Very marked redness of the skin, due to the dilatation of the subcutaneous bloodvessels; more or less profuse perspiration; more or less rapid acceleration of the pulse; speedy, sometimes immediate, alleviation of pain; temporary increase of the temperature of the body; increase of the solid matter of the urine, particularly of the urea and uric acid; and greater elimination of carbonic acid by the lungs.

The redness of the skin is not uniform, assuming a red-marbled appearance, caused by a dilatation of the bloodvessels forming the capillary network in the cellular spaces of the corium. The cutaneous perspiration differs in patients, but is always more profuse in this than in ordinary hot-air baths. The perspiration increases with the heightening of the temperature, and spreads all over the surface of the body, even in local applications, when the area under treatment may be very limited.

The acceleration of the pulse, although variable, is less pronounced than is the case in hot-air baths, and results from the dilatation of the peripheral bloodvessels, which facilitate the action of the heart and permit of more complete and stronger contractions. An hour after a luminous radiant-heat bath the pulse becomes slower but stronger than before, especially in cases of patients suffering from weak hearts.

The sedative action of the luminous radiant heat treatment is very marked. In cases of acute gout its action is practically immediate, freedom from pain being experienced almost, if not quite, from the first application of the rays to the body; in cases of sprains, contusions, articular or muscular rheumatism, and neuralgia, no inconsiderable

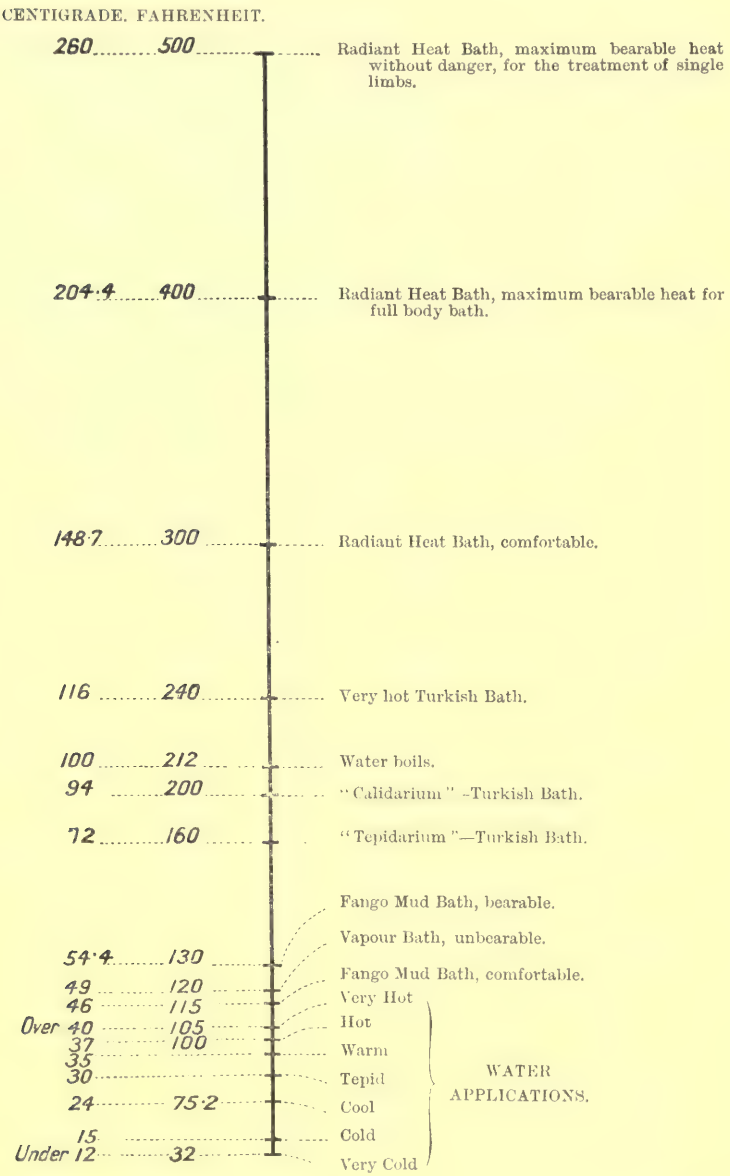


FIG. 2.—CHART SHOWING THERMOMETRIC EQUIVALENTS.

diminution of pain is experienced from the first, with an increasing feeling of relief after each succeeding application.

In a Dowsing bath having a temperature of about 94° C. and a duration of from thirty to forty minutes, the temperature of the body, taken under the tongue, shows a gradual increase of from six- to eight-tenths of a degree; rarely more than a degree. Within about twenty minutes after the bath the temperature returns to, and remains, normal.

In a Turkish bath, on the other hand, a stay of only ten minutes, with a temperature of about 107° C., is sufficient to raise the temperature of the body, taken under the tongue, more than a degree (Dobson). Twenty to thirty minutes after leaving the bath the temperature has not only fallen to the initial point, but has actually gone below it (Hoppe).

The increase in elimination of the solid matters in the urine, particularly of the urea and uric acid, seems to be mainly brought about by the increase in the temperature of the body, by the more rapid flow of the blood through the expanded bloodvessels, and by the profuse perspiration which is induced. A remarkable feature is that, during a course of the Dowsing baths, it is generally found that there is a greater volume of urine discharged than usual.

There is always a very considerable elimination of carbonic acid from the lungs, resulting in a general stimulation of the digestive organs. There is sometimes a slight acceleration in respiration, but usually it remains normal.

The combination of luminous rays, chemical rays, and heat rays gives to luminous radiant heat properties not possessed by obscure heat. Two experiments made by Bain, of Harrogate, show very important results. In the first experiment, the hind leg of a dog—anæsthetized with ether—was placed in a non-luminous hot-air case. In the second experiment, with the leg under the same conditions, the Dowsing apparatus was used, and the leg exposed to luminous radiant heat. The results obtained in each case were as follows:

	Obscure or Non-Luminous Heat.	Luminous Heat.
Temperature of the air in case	150° C.	120° C.
Elevation of the temperature of the body ..	0·5°	0·1°
Elevation of the temperature of the limb ..	1·8°	4·2°

From the physiological point of view it is not possible to form conclusions applicable to human beings, owing to the difference in the cutaneous functions, but it is nevertheless clear that luminous heat at 120° C. brings about a rise of temperature, both local and general, greater than is produced by non-luminous heat at 150° C., showing that luminous radiant heat possesses greater penetrative power than non-luminous.

Analysis of the various results obtained under the influence of luminous radiant heat enables us clearly to trace its curative effect in various diseases, and its remarkably sedative influence in the alleviation of pain. Hedley has given a very good explanation of this. He takes, as an example, one of the various forms of rheumatic or gouty arthritis, for which radiant heat baths are specially recommended. Such an example, however, is complicated by conditions peculiar to itself, and it is perhaps simpler to consider the case of, say, a recent sprain, which will illustrate much more clearly what takes place.

As an immediate consequence of such an injury, the distension of the ligaments, the more or less pronounced strain, and the laceration of the fibrous tissue, cause an extravasation of blood in the tissues, and often in the joint itself. A more or less extensive swelling rapidly sets in, followed by signs of local inflammation. The pain is intense, and on the slightest movement becomes excruciating. At the same time, both the larger and smaller bloodvessels become dilated, with, consequently, a larger flow of blood through them than is usual. The dilatation of the capillaries fed by the smaller bloodvessels in question is only proportionately less pronounced, and is brought about primarily by the flow of blood being greater than they can normally contain. The normal difference of pressure between the blood of the capillaries and the lymph contained in the lymphatic spaces increases considerably, and brings about the diffusion of a certain amount of lymph. It is even possible that the capillary circulation may be stopped by congestion brought about by the adhesion of red and white corpuscles; in this case the increased activity of the circulation is followed by stagnation, but the outflow of the cellular

elements being very active, their disintegration will rapidly produce coagulation of the lymph surrounding the seat of injury.

The surrounding tissues, which are comparatively much less hurt, become swollen, because the lymphatics are unable to absorb the products of the vascular exudations, and are distended by the lymph, which does not coagulate, since it is no longer in contact with elements in course of disintegration. The painful symptoms result mostly from the pressure produced by an exudation which has no outlet in a joint protected by ligaments and fibrous tissue which cannot expand. The lymphatic system, by extra activity of its absorptive functions, endeavours to counteract this abnormal pressure, but the compensation is not sufficient, and more or less swelling is the rule.

What is the action of luminous radiant heat in such cases ? Shortly after submitting the limb to the influence of luminous radiant heat the skin becomes red, and profuse perspiration sets in. The redness of the skin is due to the dilatation of the cutaneous bloodvessels, whilst the perspiration results from:—(1) The dilatation of the bloodvessels, particularly of those capillaries which are in intimate relation to the perspiring and sebaceous glands and follicles; (2) the direct stimulation of the cellular elements and glands by the various radiations.

Therapeutic Indications.

All affections which are benefited by hot-air baths, whether local or general, are very successfully treated by luminous radiant heat. Owing to the perfection in ventilation attained by the Dowsing apparatus, it is possible, without risk, to submit patients to temperatures varying from 150° to 232° C. in the complete—or whole-body—bath, while with the appliance for local baths a temperature of upwards of 260° C. may safely be given.

The physiological action, proved by numerous actual tests, enables the results which may be anticipated in the treatment of various affections to be set out with a very considerable degree of certainty. They are as under:

Gout.—A single bath is often sufficient to cause a very considerable alleviation of pain in cases of acute gout. The sedative effect usually begins to be felt at a temperature of about 171° C., and continues for several hours after the bath, which usually lasts for from thirty to forty-five minutes. When the pain returns, it is always less severe. Douglas Kerr usually prescribed a Dowsing complete bath in the morning, and a local application at mid-day. The duration of the severest attacks is then reduced to a few days.

Immediately after the commencement of the treatment it is noticeable that the urine becomes more abundant and richer in urea, urates, and uric acid.

In cases of subacute or chronic gout, not only is there alleviation of pain, but often the deformities of the joints, so characteristic of this affection, become less pronounced, and even disappear entirely, while the improvement in the functions of elimination has a rapid and favourable influence on the general health of the patient.

Rheumatism.—In a case of polyarthritic febrile rheumatism, where salicylates and antipyrin did not seem to give very appreciable results, a Dowsing bath of 150° C., lasting on an average about twenty minutes, was given daily. There was an almost immediate alleviation of pain, the swelling decreased, the temperature was lowered, and the volume of urine augmented. The illness lasted for a period of twelve days, but the pain was very considerably diminished from the time of the first application of the luminous radiant heat, and convalescence resulted without any complications. It is, of course, not possible to draw conclusions from any single observation, but the results in this case were such as to justify recourse to similar treatment under like conditions.

In the different forms of rheumatism—chronic, articular, muscular, blennorrhagic, and senile arthritis—the sedative action of the luminous radiant heat in the alleviation of pain is very marked, while the inability to move the affected limb gradually disappears.

Bruises, Sprains, etc.—In the treatment of these affections luminous radiant heat has proved of signal service, especially

for football players, by whom it has been extensively and most successfully used.

Phlebitis.—In cases of phlebitis, even where the œdematous swelling is at a chronic stage, radiant heat treatment is excellent. After a single bath there is a marked reduction in the size of the part affected, while continued applications result in the normal condition being restored.

Rheumatoid Arthritis.—Douglas Kerr found that at the initial stage, even at the time when the attacks are most acute, there is a rapid improvement in the flexibility of the joints and in the general condition of the patient, who not infrequently gains in weight during the course of treatment. At a more advanced period, when the joints have become deformed and there is a cessation of pain, the application of luminous radiant heat is of itself ineffectual, but if the adhesions are broken, either gradually or suddenly, and a Riss bath taken immediately thereafter, the result is a considerable diminution of the deformity, and, after subsequent baths, some recovery of the flexibility of the joints.

Sciatica.—In sciatica the results are often at variance with one another. All experience a considerable amount of relief during the bath; some are quickly cured, while others, on the contrary, have a recurrence of sharp and acute pain. These differences are probably to be accounted for by insufficient diagnosis; for instance, it is known that, whatever be the form of treatment, the same results are not obtained in cases of neuralgic as in those of neuritic sciatica.

Nephritis.—The utility of the radiant heat bath in cases of nephritis consists in the profuse perspiration which it induces, thus relieving the work of the kidneys.

General Affections, such as obesity, anæmia, general debility, and predisposition to rheumatic affections, are all beneficially influenced by the action of luminous radiant heat on the functions of nutrition, respiration, and perspiration. It has also been shown that the luminous rays increase the number of the red corpuscles in the blood and their power of oxygenation.

Summary.

The physiological action of the radiant heat bath may be briefly summarized thus:

1. Very marked redness of the skin.
2. Very abundant perspiration and the elimination of considerable quantities of carbonic acid by the lungs.
3. Acceleration of the pulse and increase of temperature; these two phenomena are less marked in proportion than in the Turkish bath.
4. Increase of the volume of solid materials of the urine, especially of the urea and uric acid.
5. Greater activity of the functions of general nutrition, and the elimination of organic oxidation products.
6. Penetrating power of the heat rays much greater than that of obscure heat.
7. Marked excitation of the skin by the chemical rays, which possess pronounced bactericidal properties.
8. Special action of the luminous rays on the red corpuscles of the blood, augmenting their number, and thus increasing their power of oxygenation.

The Dowsing Radiant Heat Baths.—In 1896 H. J. Dowsing, an electrical engineer, invented an apparatus which transformed electricity *in vacuo* into radiant heat.

Special electric lamps constituted the source of luminous radiant heat. The electric lamp is formed of a filament contained *in vacuo* within specially prepared glass bulbs, or tubes of various shapes, according to requirements. They are equally suitable for either continuous or alternating currents, and for any voltage. Instead of, as in ordinary lamps used for lighting purposes, producing light without appreciable heat, powerful heat rays as well as light rays are emitted. The heat rays are of such intensity that a thermometer placed between two lamps provided with reflectors, and separated by a distance of some sixteen inches, registers almost immediately about 204° C. The electric current, before reaching the lamps, passes through a variable resistance, which serves as a regulator, by means of which any desired temperature may be obtained.

The lamps are fixed in highly burnished reflectors of suitable formation, and are easily adjustable to any position necessary to direct the luminous radiant heat rays either on any desired part or on the whole of the body (see Figs. 3, 4, 5). The curve of the surface of reflection must be such that the heat rays emanating from the lamps are prevented from striking against the glass; otherwise, owing to the very high temperature obtained, the lamp might be injured.

The appliances thus permit of the application of luminous radiant heat as already mentioned:

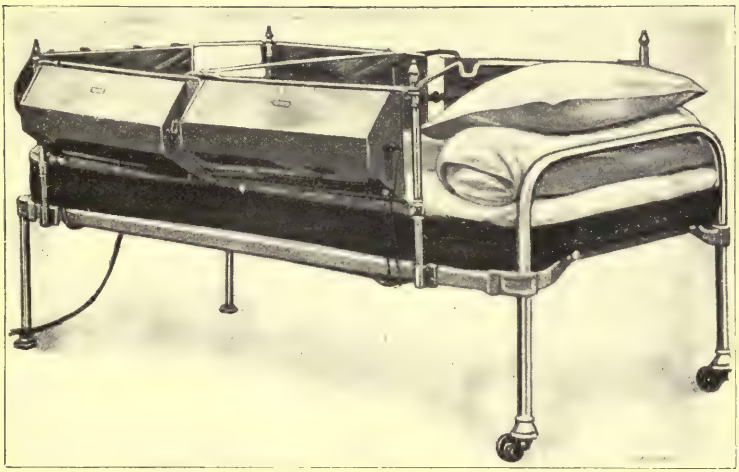


FIG. 3.—DOWSING LUMINOUS HEAT APPARATUS.

(*a*) By direct radiation without heating the surrounding air.

(*b*) By diffusion in an enclosed space automatically ventilated, thus heating the air within such enclosed space.

(*c*) By the utilization of certain determined radiations to the exclusion of others.

Appliances for Direct Radiation without Heating the Surrounding Atmosphere.—One or more Dowsing lamps are mounted with reflectors, which, by the diversity of their forms, permit of the limitation of their radiation activity

to certain parts of the body, to more or less extended portions, or to the whole of the body.

The reflectors, mounted on a vertical and movable stand, can be fixed at different heights. One can thus easily direct the luminous radiant heat rays on any part of the body of a patient sitting, standing, or reclining (Fig. 4). There being nothing in the nature of an enclosure, and the temperature of the room being in no way raised, the patient breathes the normal atmosphere—a point of no inconsiderable advantage. This method of treatment is comparable to a sun bath, with the added convenience that, by means of a

FIG. 4.—DIRECT RADIATOR APPLIED TO BACK OF THE NECK.

rheostat attached to the appliance, the intensity of the heat can be increased or decreased as may be required or desired.

Appliances for Diffusion of Luminous Radiant Heat in an Enclosed Space.—The lamps, fitted with special reflectors, are fixed in an enclosed space, varying in size and arrangement according as the treatment is required for only a part or for the whole of the body (Fig. 3). It must not be understood by the term "enclosed space" as here used that the circulation of the outer air is completely suppressed Perfect ventilation is necessary, and is secured, in order to eliminate as much as possible, and as soon as formed, the perspiration from the body brought about by the very high

temperature to which the patient is subjected; the automatic ventilation provided in the Dowsing apparatus is amply sufficient to keep the patient's skin perfectly dry.

There are also appliances for administering the heat by direct radiation without raising the temperature of the atmosphere surrounding the body.

The complete body bath consists of a bed fitted with asbestos-lined mattress and blanket, and having five reflectors, each containing two Dowsing lamps, with rheostat for regulating the current. The reflectors are fixed on metal rods, easily movable, supported by standards resting

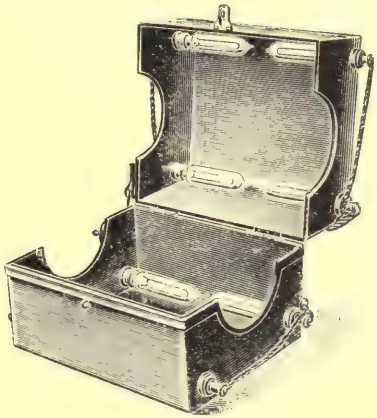


Fig. 5.—Local Radiant Heat Cabinet.

on the floor or fixed to the sides of the bedstead. The patient, being undressed, lays himself upon the mattress, and is covered with the asbestos-lined blanket, and the head only being exposed, the patient breathes the normal atmosphere of the room. The current is then turned on, and by means of the rheostat the air within the enclosed space is brought up to the requisite temperature. The local baths for the various limbs are, of course, on a smaller scale, and are made of special shapes for treating deformed limbs, etc. The apparatus for the leg or foot can be placed on a stand of suitable height, while that for the upper limbs is fixed on a stand which can be adjusted in any direction.

In all local baths, when using the asbestos-lined blanket,

the luminous radiant heat acts, not only by radiation, but also by superheating the air in the enclosed space; otherwise the radiation is direct, without in any way affecting the temperature of the surrounding atmosphere.

For all local applications other than of the limbs, the apparatus or appliance consists of a lamp and reflector attached to a movable stand, the arrangement of which is such that, by means of swivels and ball-and-socket joints, the reflectors may be moved and the rays readily directed on any part of the body.

FIG. 6.—GREVILLE GENERATOR FOR WHOLE BODY.

Appliances for the Utilization of Certain Determined Radiations to the Exclusion of Others.—For this purpose a contrivance in the nature of a highly burnished metallic cone is used, within which is placed a Dowsing lamp so arranged that the rays are concentrated at the apex, where screens of various colours can be fixed to allow the modified rays to pass. A red glass screen stops the chemical rays, and an alum solution cuts off the heat rays. A solution of sulphate of copper held between two crystal glass plates will allow chemical rays only to pass. This is a feature in therapeutics which is still in its infancy, and it is well worth

the attention of medical men. The remarkable results obtained by the late N. R. Finsen, of Copenhagen, tend to show that much may yet be expected from it.

The Greville Electro-thermic Generators.—These apparatus are usually made of aluminium, and are designed for treatment of the whole body (with the exclusion of the head), or any region in particular (Fig. 6); indeed, one of the main features of the system is the ease with which heat may be applied to any portion of the body affected. The heat is produced by the flow of electricity through sections of naked wire made of a non-oxidizable metal or compound of metals. The wires (arranged like harp strings) are wound upon porcelain insulators attached to the back of the generator, while the front or inner side is of perforated sheet aluminium. A temperature of 200° to 250° C. is easily obtainable, and is under absolute control. The electric current may be taken from the ordinary lighting mains or from accumulators.

In this system the rays convected from the naked wires are of heat-giving properties only. In fact, the main difference between the Greville and the Dowsing radiant heat baths is that in the former the invisible rays beyond the red in the spectrum are alone used, while in the latter the light rays are used. These ultra-red rays have been found to contain the maximum amount of heat, and no injurious chemical rays are permitted to enter the generator.

CHAPTER II

HOT-AIR, STEAM, AND TURKISH BATHS

The Hot-Air Cabinet Bath.

THE essential difference between this and the Turkish bath is that the head is excluded from contact with the hot air, so that the whole body is exposed to dry superheated air, while the patient breathes in a comparatively

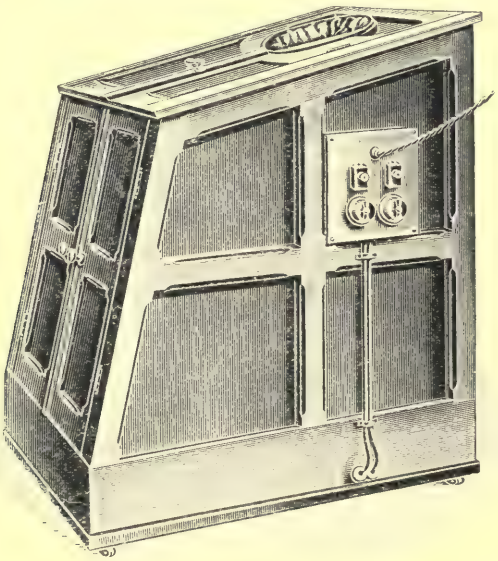


FIG. 7.—HOT-AIR CABINET HEATED BY ELECTRICAL RESISTANCE WIRES.

cool atmosphere. Many portable and inexpensive forms of the bath are sold, made of waterproof cloth stretched on a wooden or metal frame, and these are often perfectly efficacious. There are also more elaborate wooden cabinets constructed, lined with zinc or cork (Fig. 7).

Electricity is the most suitable means to heat the air, because the temperature is easily under control, and can be increased up to about 150° C. (the exact amount can be read off on a thermometer). The air is quite dry, and not vitiated by any vapours of burning gas or oil, and the patient breathes air of ordinary temperature.

The heat is generated by the electric current passing through suitable resistance wires, which are wound over porcelain frames so that the air has free access. A smaller or greater number of these electric stoves can be switched on to regulate the temperature.

The cabinets are made either for the whole body or only for an arm or leg. Other sources of heat employed are small gas stoves, spirit lamps, steam coils, or paraffin stoves. Some of these are not free from risk, and more than one patient has been severely burnt. The electric method or the steam coil is certainly the best. If a lamp or stove be used, it must be lighted before the patient enters the bath. The bath may be administered to a patient in bed by using a special frame and covering, under which a tin pipe is led to conduct the hot air. This is a common hospital device.

The temperature of the bath should vary from 65° C. to 120° C., and the duration may be from six minutes to one hour, according to circumstances. The maximum beneficial effects can be obtained in the generality of cases in thirty to forty minutes.

Before entering the bath, the patient should remove all his clothing, and wrap up in a blanket or large Turkey bath sheet while waiting. Before and during the bath, water, hot or cold, should be freely drunk. The head should be enveloped in a cool, damp cloth.

On leaving the bath, the patient is given a spray or rain douche, and if necessary a vigorous reaction insured by friction. In rheumatic cases it is sometimes well to prolong the perspiration in a gentle form by enveloping the patient with warm blankets, and merely finish off with a cool sponging.

Therapeutic Indications.

Hot air is of great value in the treatment of obesity, uric acid diathesis, fatty glycosurics, neurasthenia, or, indeed, any auto-intoxication. Many organic forms of chronic nervous disease, as locomotor ataxia, are materially benefited by the use of hot-air baths, even though we admit that *cure* is out of the question. Various anæmias also are helped, care being taken not to employ too high a temperature or unduly prolong the bath.

All morbid conditions dependent on congestion of the various internal organs are improved by judicious employment of this bath. In actual hyperpyesis particular care

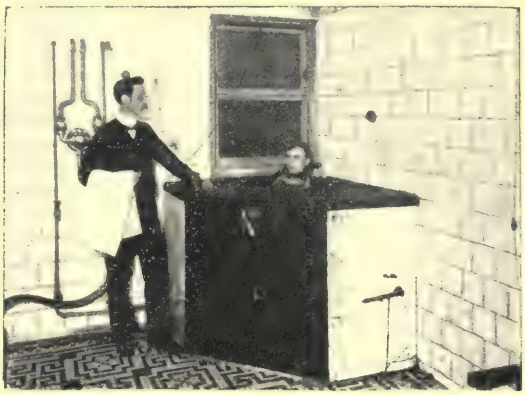


Fig. 8.—The Steam Cabinet.

is necessary in prescribing it, however, and the head should be invariably kept cool by means of an ice-bag or towel wrung out of ice-cold water.

The Steam Cabinet Bath.

This is identical with the Russian vapour bath, except that, instead of being shut in a room into which the steam is introduced, the patient sits in a cabinet with his head excluded (Fig. 8).

The cabinet, usually made of wood, should be practically steam-tight. The steam may be generated in the cabinet itself or, which is better, conveyed from an outside source.

The patient may be vertical or horizontal, and sits or lies on a latticed wooden seat, under which run pipes with small perforations by means of which the steam enters. The temperature of the bath rises in direct proportion to the rapidity with which the steam enters. The temperature desirable is from 40° to 46° C. The patient can tolerate higher temperatures after a series of baths. No sensation of burning is experienced when once free diaphoresis has been established. As in all such procedures, the head of the patient must be enveloped in a damp towel. Diaphoresis is hastened and increased if water be freely drunk.

On leaving the cabinet, the patient should have a spray or rain bath, beginning with water at 30° C. and cooling down to 15° or 12° C.

Duration of the Bath.—On the average from fifteen to thirty minutes. Brief exposures of two to five minutes are employed as a preliminary to a Turkish bath or cold stimulating applications. Baths of over thirty minutes' duration should not be employed except in the case of very robust patients.

Physiological Effects.—After a short application the cutaneous vessels become dilated and the body surface warm. In five or six minutes perspiration begins, and the skin reddens. The body temperature rises, respiration and pulse are accelerated, and metabolism is increased. The white blood-corpuscles are almost always increased, but the red diminish, unless a relative increase takes place owing to inspissation of blood from much fluid loss. There is loss of body-weight, varying with the duration of exposure, and often amounting to several pounds.

Therapeutic Indications.

Brief baths are employed in anæmia and neurasthenia, while more prolonged baths are of service in various constitutional dyscrasia, in rheumatic affections, uric acid diathesis, chronic renal disease, and in various skin affections, such as psoriasis. In common colds, chills, and febrile affections, the diaphoresis induced is also useful.

Generally speaking, febrile diseases are a counter-indication, as are also organic nervous diseases (if we exclude some of the parasyphilides at an early stage, and chronic arterial degeneration).

FIG. 9.—THE CALIDARIUM (TURKISH BATH).
From the Baths at the Cairn Hydro, Harrogate.)

The Turkish Bath.

The Turkish bath is a very ancient procedure, and dates from the time of the Roman Empire. To-day, in various parts of Italy, in Rome and elsewhere, the ruins of such

baths, used in the time of Nero, may be seen. In Jerusalem a bath of this nature, built at the time of Herod, is still used regularly, after nearly two thousand years have elapsed. Practically every nation and country has some peculiar

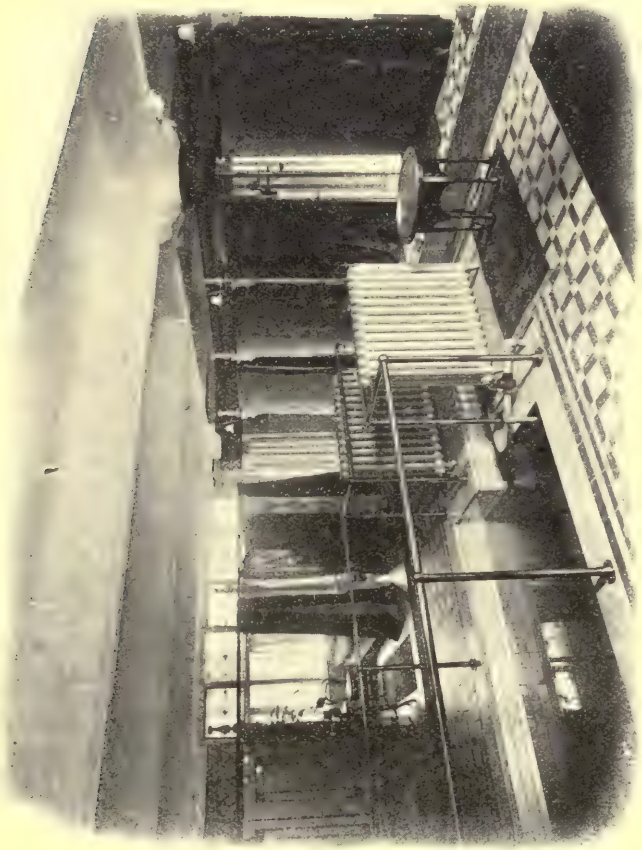


FIG. 10.—THE COOLING ROOM (TURKISH BATH).
(From the Baths at the Cairn Hydro, Harrogate.)

form of a "sweating bath," some of which are extremely dirty and unpleasant. Probably the Turkish bath is the most elaborate and luxurious type of this variety of bath. In the modern form it consists of a series of rooms comprising at least the following compartments:

1. The *Tepidarium*, a room heated to a temperature of 54° to 72° C.

2. The *Calidarium*, a room heated to a temperature of 65° to 93° C. In some cases there is an annexe to this apartment heated up to 120° to 150° C., but in smaller suites this is usually dispensed with (Fig. 9).

3. The *Shampoo Room*, which is furnished with marble slab, douche apparatus, etc., and attached to this room is frequently found a plunge or swimming bath at a temperature of 12° to 15° C. for the more vigorous patients to use as a final measure in cooling.

4. The *Cooling and Dressing Room*, with suitable couches for patients to rest on from forty minutes to one hour after a bath (Fig. 10).

The rooms are heated by means of a furnace, or indirectly by a steam heater. Ample provision must be made for ventilation, for inefficiency in this respect will cause much oppression and headache to those using the bath. The outlet for foul air should be near the bottom of the room, communicating with a ventilating shaft. If heated by hot air, the opening for its admission is best placed at a point two or three feet above the level of the floor.

Technique.—The patient, having removed all his clothing with the exception of the loin cloth demanded by modesty, drinks a glass of water and lies down on a couch in the tepidarium. A moist cloth is often placed around the head. The time which elapses before the onset of perspiration varies greatly in different subjects, but, on an average, some moisture appears on the skin in from ten to fifteen minutes, and very soon the patient is perspiring profusely. When perspiration is slow, the activity of the skin is increased by the brisk application of friction gloves.

Two or three minutes spent in the Russian bath or steam-box prior to entering the Turkish soften the skin and facilitate a good sweat. The feet may further be placed in a hot foot bath and hot water freely imbibed. Such patients as do not perspire even with these adjuvants usually experience a good deal of oppression and discomfort: the skin becomes very dry and hot, and they should be

removed from the bath, or they may become seriously upset. These cases, however, are the exception.

Perspiration having been properly established, the calidarium or second room may be entered, and profuse perspiration allowed for about ten minutes. Many people are unable to stand the intense heat of the third room even for a few minutes, but hardened veterans enjoy it.

A suitable amount of diaphoresis having taken place, the patient enters the shampoo room and lies down on the slab. He is briskly massaged from head to foot, much superficial epidermis, already loosened by the perspiration, being thus removed. Lathering follows, hot soapsuds being ladled on to the skin and well rubbed in with a loofah, preferably brought by the patient, so as to avoid the possibility of infection. The shampooing is a most comforting process, and is continued until the skin feels smooth and polished. A douche or spray douche, from 25° C. down to 15° C., or even lower, is now applied. This has a tonic effect, and also serves to completely remove the soapsuds. The plunge bath may be taken or omitted, according to circumstances, and then the patient, wrapped in a warm sheet, lies down in the cooling room until the pulse is normal and the skin thoroughly dry. A cup of coffee at this stage is beneficial and refreshing in many cases.

Where the object is reduction of weight, a daily Turkish bath up to one hour in duration may be employed; but for the average person three a week are amply sufficient, and with feeble patients these must be of brief duration.

Physiological Action.—The sweat glands are powerfully stimulated, and the amount of secretion may rise from the normal 1½ ounces per hour to several pounds per hour. A loss of 2 pounds in weight is quite common after a full Turkish bath. Unless the patient drink water freely, the blood-volume will be considerably reduced in these circumstances and cardiac enfeeblement result. Blood is withdrawn from liver, spleen, and all the internal organs, and the absorption of fluid from the intestines which takes place leads to subsequent constipation in some cases.

By the inhalation of the hot air the pulmonary mucous

membrane is excited to secretion to some extent, rapid volatilization occurring. The respiration is mainly thoracic.

The cardiac beats quicken and the mean blood-pressure rises soon after the bath is entered, and some fulness in the head and discomfort may be experienced, lessened by the foot bath mentioned above. The mean blood-pressure falls and the pulse slows with the onset of perspiration. The rise in body-temperature is so slight as to be negligible in the majority of cases. In very obese persons this may not be the case, however, as the heat loss in such cases is not proportionate to the heat gain. Kellogg points out that such patients have much smaller skin surface in proportion to their weight than spare individuals.

Therapeutic Indications.

These are practically the same as the hot-air bath, but the Turkish bath cannot be employed for many cases for which the hot-air bath is quite advisable. It is contra-indicated, *e.g.*, in arterio-sclerotic conditions, cardiac asthma and dilatation, exophthalmic goitre, in patients with unusually high blood-pressure, and in advanced renal disease.

The Tyrnauer Apparatus.

It is claimed for this apparatus that the air enclosed is uniform in temperature, a condition quite unusual in hot-air apparatus. Indeed, in some machines of this character there may be a difference of as much as 37° C. between different parts, depending on the source of the heating This, in the Tyrnauer apparatus, consists in electrical resistance wires lying in a trough beneath the apparatus. A temperature of 80° to 95° C. can be attained in five to six minutes, and as high as 148·7° C. in ten minutes. The temperature is also absolutely under the control of the person manipulating the machine, and can be quickly reduced or raised. The machine is made of oak or mahogany, with metal such as copper or nickel, and lined with asbestos. There are three separate sources of heat, and any one of them can be readily turned off or on. The regulation of the

temperature is further controlled by the use of a perforated asbestos screen, which can be raised or lowered to lessen the degree of radiation from the sources of heat. The resistance wires rest on a "poilite" asbestos tile or plate, and are regulated by switches. Double fuses guard against damage from a "short." A thermometer is fixed in a prominent position so that both the patient and the attendant can read it. The amount of current used varies from 5 to 18 amperes, and an ordinary treatment uses up about 4d. to 5d. worth of current. There are various apparatus for different parts of the body, like the Greville, and the local parts are particularly well adapted to the different parts for which they are designed. All the external surfaces of the joints are treated. This is a distinctly thermotherapeutic measure as opposed to a light treatment, and in no way compares, *e.g.*, with the leucodescent lamp. It is *dark* heat.

The apparatus is about the most costly of any of these, and has an additional drawback—German origin. One has been in use for a number of years at the London Hospital with considerable success, and also at Llandrindod Wells.

Baths (Berthe Apparatus).

This apparatus has been in use for many years at Vichy and later at Harrogate. It is a valuable method of treating gout, rheumatism, sciatica, and other forms of neuritis. It is a very strongly built chamber made of mahogany and copper, and by means of it the following treatments can be given:

(A) 1. Dry hot air. 2. Steam. 3. Medicated vapours (terebinth, menthol, and wintergreen). 4. Oxygen and CO_2 gas for the whole body.

(B) The separate treatment of the arm, leg, or feet by *local* baths.

(C) To keep the temperature of the bath hotter at the feet than the head a specially controlled system of ventilation renews the air in the bath and removes excreted matter as it is emanated.

(E) The temperature of the air can be kept constant or it can be altered at will.

(F) The chamber can be disinfected completely and instantly by means of antiseptic vapours such as thymol and formalin.

Treatment may be administered with or without medicated additions, nasal or pharyngeal douches, or inhalation, which can be taken during the bath. A thermometer is so fitted as to allow the bather to note the exact temperature of the bath at any moment, and the patient can leave the bath unaided at any moment provided he is not so crippled as to need crutches and arm help. The hot chamber is closed at the upper part by means of a collarette padded with rubber, allowing the patient the utmost range of comfort; he can use his hands for holding a book or newspaper. A seat is fitted which can be automatically regulated to the size and configuration of the patient.

CHAPTER III

PHOTOTHERAPY

It has been shown that sunlight is made up of various kinds of rays, and the existence of the following have been clearly demonstrated: (1) Heat rays; (2) light rays; (3) chemical or actinic rays.

The heat rays, although invisible, make a powerful impression on the cutaneous nerves. They are found in the red portion of the spectrum; while the light rays are in the yellow portion, and the chemical rays in the violet and ultra-violet portions. Chemical rays are invisible, but act on the skin. By various devices any of these elements in a sunlight ray may be picked out or eliminated.

The electric arc light and sunlight are very similar, the former containing more actinic or chemical rays in beams of equal luminosity. The incandescent light contains a large portion of heat rays. The effects of exposure to light are due chiefly to the action of the chemical and thermal rays. The powerful effect of light on plant life is shown by the manner in which plants, leaves, or flower-stalks bend towards the origin of the light in their growth. Light rays are powerful for good or ill, however, and, as is well known, concentrated sunlight will scorch and destroy plant life.

On animal life the action of the chemical rays is well demonstrated in sunburn in man, and the darkening of the white coat of animals long exposed to sunlight. The pigment in the skin of races resident in tropical zones is largely a protective measure.

Action of Light on Metabolic Processes.—The output of CO_2 is increased in all animals when exposed to light; all tissue changes are more rapid, and if food be withheld more weight is lost in daylight than in the dark. The metabolic processes of prisoners confined in solitary, dark-

ened cells, fed on a scanty supply of bread and water, are sluggish in the extreme, with resultant mental depression and sense of humiliation. This also has much to do with the occurrence of cretinism in the deep, sunless valleys of Switzerland.

Tissue oxidation is unquestionably increased by sunlight in all living creatures, and in the human species this is due to reflexes set up by the stimulation by light rays of the nerve endings in the skin.

Exposure to powerful sunlight causes headache and vertigo, due to too powerful stimulation of the optic nerve; similar results are seen after prolonged exposure of the naked trunk. Black races are protected against the actinic or chemical rays by the pigment in their skin, which is impenetrable to these rays, and a white man can acquire temporary immunity similarly by the application of some black water-paint.

Sunstroke is of course due to over-exposure of the central nervous system, head or neck being insufficiently covered, to strong sunlight. In Europeans, a very brief exposure suffices, but in the native races some immunity is acquired by the nervous system becoming so far habituated to the special stimulus. In India it is not uncommon, even at noon, to see natives stretched on the ground asleep, absolutely unprotected against a scorching sun.

The functions of the skin are all stimulated by such exposure to the sun's rays, irrespective, to some extent, of the temperature of the surrounding air. Profuse perspiration is induced by the action of the chemical and the heat rays, the latter being most concerned. Toxic substances in the blood may be thus got rid of, but further, light has a most powerful germicidal influence, rapidly killing parasites, fungi, and several of the more virulent types of bacteria.

Therapeutic Application of Light.—(1) Sunlight; (2) electric light: (*a*) arc, (*b*) incandescent. It has been clearly demonstrated that the nature of these forms of light is the same, irrespective of the source, although the latter is of importance in considering the questions of convenience in practical application and the therapeutic results.

Sunlight contains all these types of rays in abundance; of electric lights, the arc resembles it most. The incandescent light contains about 90 per cent. of heat rays, the balance being made up of small proportions of luminous and chemical rays. In this country this bath is largely restricted to the indoor form, owing to the low temperature prevailing during most months of the year.

Formerly there was a large open-air sun bath at Peebles, but it has been done away with, and patients are treated in this manner on a flat roof. At Battle Creek there is a large one combined with an arenarium or sand bath, patients lying about in the warm sand. This is an excellent idea.

The Indoor Sun Bath.

The indoor sun bath is more convenient in this country, and can be easily arranged given a south exposure and

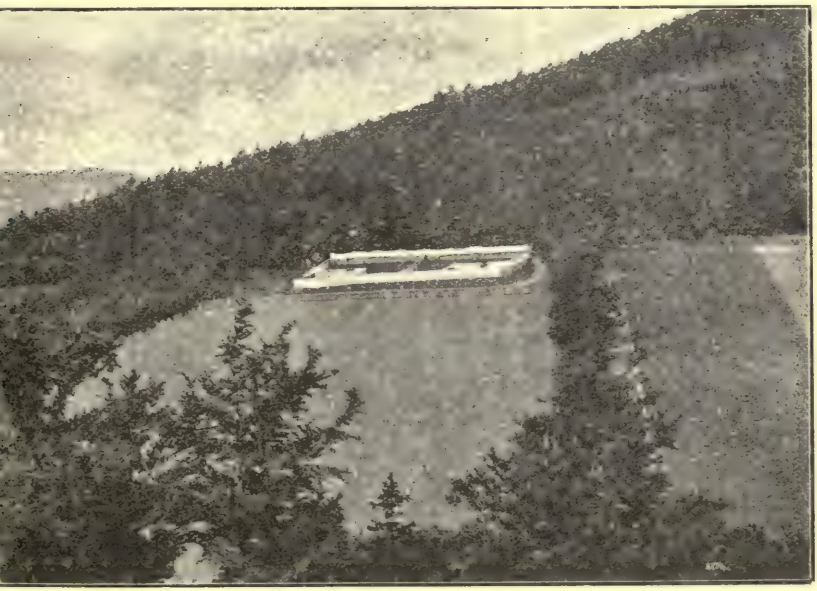


Fig. 11.—Sun Bath.

sufficient sunshine. The windows must be kept open, allowing unrestrained play of the light, as the valuable

ultra-violet rays are absorbed by the glass. The patient's head should be protected by a moist towel, but all other clothing or covering except the loin cloth demanded by decency may be dispensed with. Patients with tender, sensitive skins must go warily, as erythema solare is easily produced, and is very irritating if not painful. The duration of the bath will largely depend on the season of the year and the prevailing weather conditions. Three minutes is very often long enough to start with. Caution is always needful,

FIG. 12.—OPEN-AIR SUN BATH AND ARENARIUM (BATTLE CREEK).

for too long exposure will cause headache, lassitude, and depression if the sun be hot, and possibly a severe chill or even pneumonia if the air be cold.

Individuals with dark hair and complexion are less sensitive to the influence of sunlight than fair, blue-eyed people, and for the former the exposure may often be allowed for half an hour or more without harm resulting. Custom

counts for a great deal, too, and after the training and toning up afforded by a series of baths, exposure for two or three hours daily can often be tolerated and enjoyed. The skin usually darkens considerably, from increase in pigment.

In northern temperate latitudes the intensity of the sun's rays is greatest from mid-June to mid-September, and the intensity always increases with the altitude.

After-Treatment.—At the conclusion of the bath the patient should be taken in hand by an attendant and given

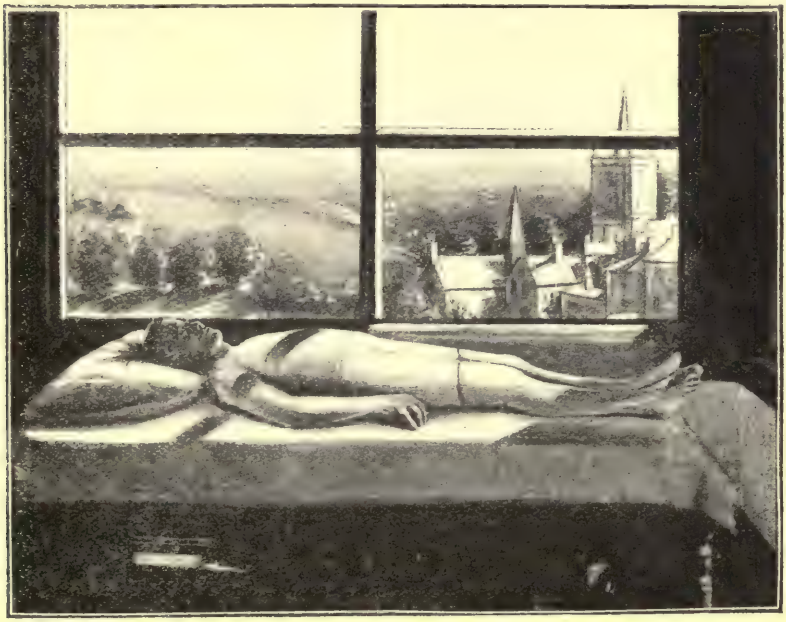


Fig. 13.—Indoor Sun Bath.

either a wet-sheet rub or a cooling spray or douche, or in the case of robust and vigorous patients a plunge and short swim is a beneficial termination.

Temperature of the Patient.—The patient's temperature should be taken immediately before, during, and after the sun bath. The temperature usually rises from 0·5° to 1° C.

In individuals who perspire freely the temperature usually rises but slightly, but in persons with dry skins, such

as chronic dyspeptics, diabetics, and those suffering from extensive scleroderma, a higher temperature is soon shown.

Physiological Effects.—The reaction induced by a sun bath represents the effect of the combined influence of the thermic, luminous, and chemical elements of the sun's rays.

The heat rays elevate the body temperature, just as the hot air or steam do in the hot-air or vapour bath cabinet, either by causing an accumulation of heat or preventing its escape by radiation and evaporation. All the organs of the body are stimulated, and the metabolic activity is increased. There is increased oxidation of proteid substances, increased consumption of carbohydrates and fats, and increased output of CO_2 correspondingly. The cutaneous vessels are dilated, the sweat glands rendered more active, and the actual amount of sweat may rise from the normal average of 1½ ounces per hour to 2 or 3 pounds, particularly if the patient is taking exercise (*vide supra*).

The blood is markedly diverted from the internal organs to the skin surface, and these viscera are thus decongested for the time being. The patient may be rendered very drowsy by cerebral anæmia.

Finsen has shown that the chemical rays are equally active as regards the nervous system, and have a markedly tonic influence.

Therapeutic Indications.

It will be at once seen that in all cases with defective metabolism as a participating cause in the morbid condition we have a fair mark for these sun baths. Among the most common of these are dyspepsia, diabetes, obesity, and that congeries of symptoms herded together under the term so commonly used by the laity, "the uric acid diathesis," with which perhaps uric acid has very little to do. In anæmic conditions the hæmopoietic centres are stimulated, toxins are eliminated, and an accompanying and often resultant neurasthenia is relieved. In some forms of renal disease, hepatic congestion, and early cirrhosis, benefit is derived very frequently. In tuberculous conditions an early improvement is noticeable when the climate permits of the sun bath

forming a part of the open-air régime now so generally employed.

Even skin diseases such as eczema and psoriasis have been found to benefit, but we must proceed cautiously; mixed bathing with such cases is difficult, and a very severe erythema may be caused if the cure be in any way pushed. Caution is needed with cardiac patients, as syncopic attacks may come on, and with insomniacs care must be specially taken to keep the head cool with damp coverings.

Electric Light as compared with Sunlight.

Electric light possesses almost identical properties with those of the sun's rays, whether we are referring to the arc or incandescent lamp. In the former the luminous rays predominate, and in the latter heat rays. Siemens arrives at the following conclusions as regards the physiological effect of the electric light:

1. Electric light has the effect of producing chlorophyll in the leaves of plants, promoting growth, and favouring protoplasmic activity.

2. The action of artificial light is identical with that of daylight.

3. Under the influence of electric light plants have been observed to sustain increased stove heat without collapsing, showing the value of light as a vital stimulant.

4. It has been found that bacteria are killed in a few minutes by exposure to the concentrated rays of a 6,000 candle-power lamp.

The Electric Light Bath.

This consists of a cabinet, vertical or horizontal, in the sides of which are fixed from thirty-five to fifty electric light bulbs, some white and some of blue glass, to cut out the irritating actinic rays. The inside may be simply white enamelled, but is preferably covered with opalite glass or mirrors, which latter enhance the light effect. If vertical, the patient sits erect on a stool with his head outside, the naked surface of the body being exposed to the action of

the lamps for a period of from ten minutes up to twenty-five or thirty. The size most convenient is about five feet in height and four feet wide. The lamps are 32 candle-power, and are set in vertical rows, seven in a row. The stool should be of the music stool adjustable type, as some patients may find the bath too high to adjust their head outside comfortably with a standard stool. In any case, many patients find the vertical bath keeps them in a somewhat

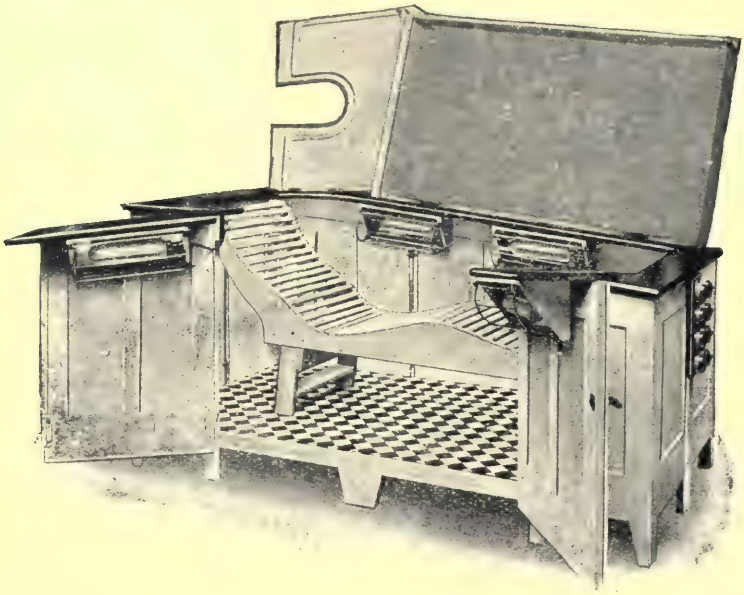


FIG. 14.—THE ELECTRIC LIGHT BATH (RECUMBENT).

constrained position, and of course in weakly subjects the tendency to faint is greater. Thus there is much to be said for the horizontal type of bath as shown in Fig. 14

Precautions.—The feet of the patient should be warm and the head kept cool. A foot bath may be used for the first object, and the head be covered with a damp towel or even Leiter's tubes for the latter.

The time spent in the bath should rarely exceed fifteen minutes. Free diaphoresis occurs usually after this, and the patient does better usually if transferred to a hot-water bath or given a Vichy douche. The thermometer in the light

bath should register as a mean 65° C., but the temperature may vary from 32° to 94° C. The heat is conveyed to the patient by radiation, not by conduction, so that the temperature of the air immediately around the patient is of little moment. The less moisture there is in the air the

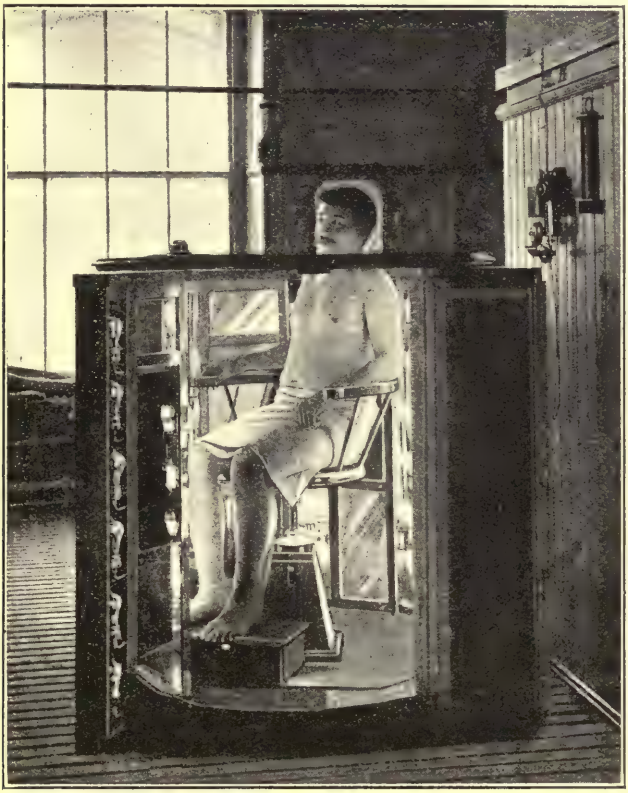


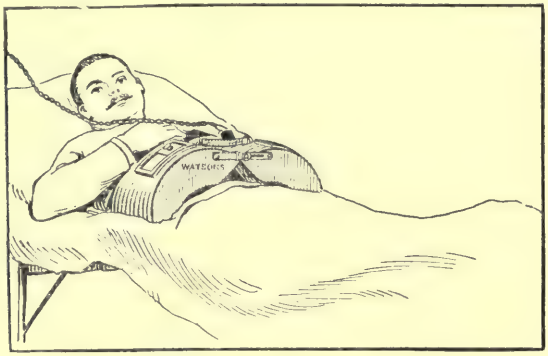
Fig. 15.—The Electric Light Bath (Upright).

higher will be the temperature tolerable to the patient. It is therefore essential that, whatever the type, the ventilation of the bath be good.

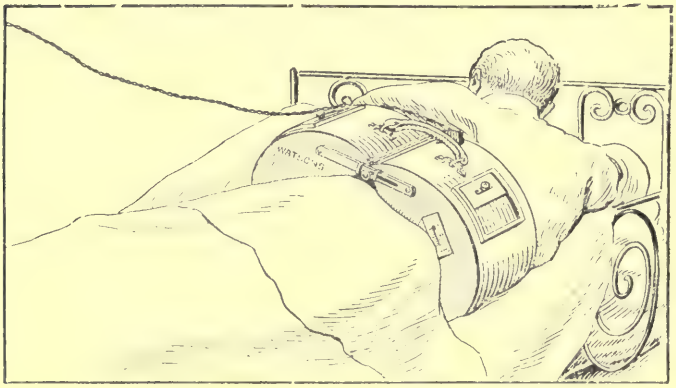
While the number of lamps in the bath is actually fixed, the number of lamps actually alight can be readily varied by the use of the switches, there usually being one for each row of lamps.

Some baths have an arrangement whereby the arc lamp can be turned on through an aperture from outside to any part it is specially desired to treat.

After the bath is over, the patient is either transferred to a hot bath of plain water, to a Vichy douche, as mentioned



Applied to Base of Thorax.

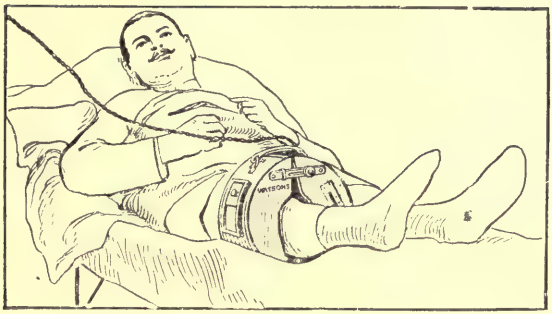


Applied to Lumbar Region.

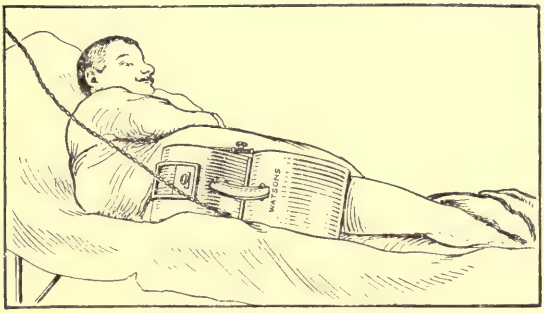
Fig. 16.—Local Electric Light Bath.

above, or is shampooed and carefully sprayed down and the wrapped in a warm bath sheet and allowed to rest.

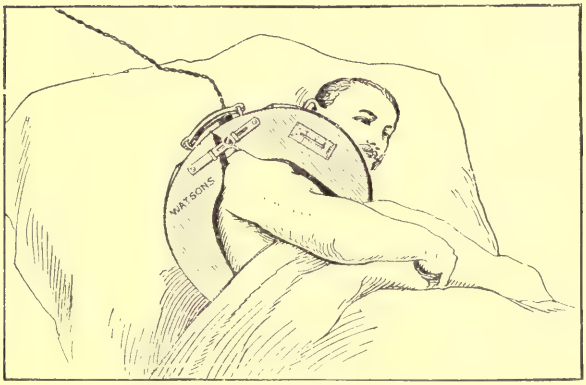
1. **Physiological Action.**—This bath is most valuable as a heating agent. By prolonged application the skin of the patient is reddened, the superficial vessels dilated, just as in



Applied to Knee.



Applied to Sciatic Region.



Applied to Right Shoulder.

FIG. 16A.—LOCAL ELECTRIC LIGHT BATH.

an ordinary vapour bath, the effect being kept up for a considerable time. The bath is essentially an eliminant in effect, and produces free perspiration more rapidly than any other known procedure.

2. The sweat appears within five minutes of the patient entering the bath, irrespective of the actual air temperature in the cabinet. The time required to induce diaphoresis in an ordinary Turkish bath is very much longer; indeed, some persons never perspire at all.

3. The body temperature rises rapidly in the electric light bath—4° to 5° F. in twenty minutes.

4. The increased elimination of CO_2 is very marked, and evidences the active oxidation and tissue changes induced by this procedure.

Kellogg estimates the increase as nearly 50 per cent. Comparatively, in a Russian or Turkish bath the increase is only found to be 10 to 11 per cent. The respiration of the patient, while considerably quickened, is free and unembarrassed. None of the oppression and distress met with in the Turkish or Russian bath is induced.

5. The blood-pressure, after a primary rise, is lowered. The red cells are increased by about 15 per cent. The pulse-rate is somewhat quickened.

Therapeutic Effects

1. **Revulsive Effect.**—By the rapidly induced and prolonged dilatation of the cutaneous bloodvessels the blood is diverted to the surface of the body, and passive venous congestion converted into an active arterial hyperæmia. The longer the bath is continued, the more intense does this effect become.

2. **Sudorific Effect.**—Perspiration is induced more quickly and vigorously than by any other known agent, with a minimum of inconvenience and discomfort to the patient. Copious water-drinking during the bath encourages the perspiration and keeps the blood-volume constant. As above mentioned, the head should be wrapped in cold cloths, especially if the bath is prolonged.

3. For promoting the absorption of morbid exudates, such

as pleural effusion, ascites, or joint effusions, the electric light bath is admirably adapted.

4. **Tonic Effect.**—A brief application—five to eight minutes—has a bracing and tonic effect. The after-application of a warm to cold spray and a dry rub enhances the stimulating effect.

Therapeutic Indications.

The condition of disordered metabolism which goes under the name of "uric acid diathesis" is much benefited by a series of electric light baths.

By the increased oxidation and improved metabolism the nitrogenous by-products and toxic substances are gradually eliminated, with proportional benefit to the patient. The application should be made two or three times weekly, and should be combined with suitable diet, free water-drinking, and plenty of exercise. Allied conditions which similarly benefit are rheumatism, gout, diabetes, and some forms of neurasthenia.

Fat glycosurics are most benefited. The skin is rendered more active as an organ of elimination, and the free diaphoresis and increased oxidation reduces the amount of sugar in the urine. The blood is rendered more alkaline, and the tendency to "acid intoxication," so well known in glycosuria, correspondingly diminished.

Obesity.—In the treatment of this condition the electric light is a most potent and valuable agent. As stated above, the increase of tissue consumption during the bath amounts to from 45 to 50 per cent., and as three-fourths of the energy of the body is consumed in heat production, the value of this is very obvious. An increase such as this, kept up for from thirty to forty minutes several times every week, naturally results in a considerable weight reduction. The heat elimination and tissue consumption is greatly increased when the temperature of the air surrounding the patient is lower than the body temperature.

Neuralgia, including sciatica, myalgia, and the various vague pains associated with auto-intoxication, are all benefited markedly. Conditions such as plumbism and

arsenical poisoning and neuritis are improved, a daily application being sometimes necessary. In a minor degree anæmic conditions are benefited, and the recuperative powers of the body helped to re-establish the normal hæmopoietic processes.

Renal Disease.—Few measures afford such marked relief to acute and subacute renal disease as the electric light bath. Prompt relief is afforded to the inflamed organs by so large a portion of the blood being diverted to the skin. The application should be rather longer than usual, the patient being refreshed from time to time by a rub with a friction glove wrung out of hot water. The usual precautions as regards keeping the head cool and the feet warm are especially necessary, and great care is further requisite to avoid a chill, which would more than counteract any good effects of the bath. In acute cases the bath may be repeated several times in the twenty-four hours, and a condition of continuous diaphoresis is maintained.

In chronic granular kidney special care is called for in prescribing these baths, and in administering them if the risk be taken; there is always a danger of apoplexy. In cardiac hypertrophy and dropsy special care is also needed, and high temperatures and long exposure must be avoided. The bath should be brief in duration, and an ice-bag or cooling application be placed on the patient's head.

There are a variety of other conditions which may be more or less helpful which it is hardly needful to enter into here. In conclusion, however, one may say that the therapeutic value of the electric light bath and its great advance over the Turkish can hardly be overstated. It is, in the first place, a preventive of disease, chills, and auto-intoxication *par excellence* in the average healthy person and as an eliminant has no rival, bringing into play in full the largest gland in the body—the skin, by means of which such a very large proportion of waste products is normally eliminated.

The Leucodescent Lamp.

This is a 2,000 candle-power therapeutic lamp swung on pulleys so as to be easily adjusted to any part of the patient. One of us has used a lamp of this type for about ten years, and with the greatest satisfaction. Humphris also speaks very highly of it.

The globe carrying the incandescent filament is surrounded by a brightly polished metal hood, the whole being swung on a sort of iron trolley with a counter-weight, rendering adjustment very simple.

The method of applying the lamp is to swing it slowly backwards and forwards over the affected part for about twenty minutes to half an hour. The distance it is kept from the skin must depend a great deal on the tolerance of the patient, which, of course, varies greatly with the individual. The skin must be bare for direct application, no fabric of any kind intervening. The application is neither painful nor unpleasant if the heat be controlled by the swinging movement above mentioned. The duration of the treatment will vary with the nature of the case, as will the frequency. In acute cases short treatments frequently repeated are often most efficacious. If the pain is relieved and checked by daily application, then these should be employed until it disappears. A sharp attack of lumbago will close up in a few days, while a long-standing neuritis or sciatica may take weeks.

The *modus operandi* is, of course, by causing passive congestion initially and preparing the way for more efficacious massage. The sweat glands are stimulated and the capillaries dilated; normal circulation is promoted, and venous stasis removed. It is even suggested that the light has a bactericidal action on superficial germs.

Accordingly, pain is relieved and the functional activity of the skin and deeper glands restored. Humphris goes so far as to say if pain is not relieved by this procedure the services of a surgeon will be required.

Of the conditions which are greatly benefited and cured, rheumatic affections of muscles, joints, and nerves come

first. Humphris has used the lamp in painful digestive conditions, however, with good result, and also in neurasthenia and insomnia. Boils and carbuncles are relieved and the cure accelerated. Pleurodynia is a typical condition to which relief is afforded, and "stiff neck."

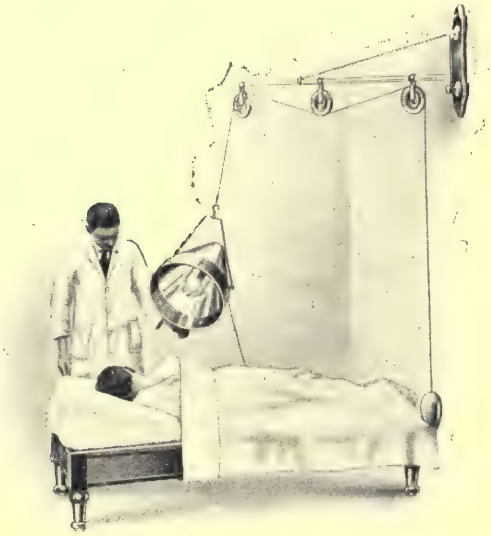


Fig. 17.—The Leucodescent Lamp.

In skin affections, acne, tinea sycosis, some forms of eczema, and psoriasis, appear to be benefited if treated with care and discretion.

Taking it all round, there is no more simple and effective piece of apparatus in the domain of physio-therapy with such a wide field of usefulness in relieving painful affections.

SECTION II

HYDROTHERAPY

CHAPTER I

GENERAL PRINCIPLES

THERMOTHERAPY consists in the application of heat as a therapeutic agent at all temperatures and irrespective of the media by means of which the heat is conveyed. Thermal applications include hot and cold water baths, and air, vapour, electric light, and sunlight baths.

One of the commonest means employed for conveying thermic stimuli to the body is water, and in describing the temperature of such applications or procedures (see also chart, Fig. 2), the following standard is customary:

	Temperatures.
Very hot applications	over 40° C.
Hot applications	37° to 40° C.
Warm ,, ...	34° to 37° C.
Tepid ,, ...	27° to 33·5° C.
Cool ,, ...	18° to 27° C.
Cold ,, ...	12·5° to 18° C.
Very cold ,, ...	0° to 12·5° C.

Hydrotherapy consists in the systematic application of water at various temperatures and in varying form to the surface of the body for therapeutic purposes. Water may produce its effects by (1) its temperature, (2) its volume, (3) mechanically, (4) chemically.

Water possesses such physical properties as render it an excellent medium for conveying temperature impressions. It has a remarkable capacity for heat absorption without material rise in temperature, and gives off heat without much temperature reduction. It takes a much larger amount

of heat to raise the temperature of a pound weight of water 1° C. than an equal bulk of oil or metal. It is for this reason that water is used for "thermophores" and the domestic hot-water bottle, and on this fact depends the even temperature of insular climates. The heat-conducting power of water, as compared with that of air, is as 27 to 1, and much more powerful thermal impressions are made on the skin by water than air, the temperature being the same.

As a result of different temperatures water undergoes peculiar changes, solidifying at 0° C. and becoming gaseous at 100° C., the volume increasing 1,700 times. The heat absorbed and evolved respectively in these changes in its molecular constitution is utilized in various ways in hydrotherapy.

The temperature of water, more than that of any other medium, is readily adapted to individual cases and with great precision. The range of safety in temperature is from 1° C. to 48·5° C.; long-continued application of water above or below this temperature may produce tissue necrosis. Water is thus said to possess a high degree of *thermic flexibility* (Baruch).

The fluidity of water allows of its local and general effects being regulated with the utmost nicety and precision, and the size, form, and character of its application—in the form of a stream or douche—can be instantly changed. Therapeutic effects of great value are brought about by the mechanical action of water emitted under various degrees of pressure, varying from the mildest stimulation to intense irritation. Cold and heat and gradations of temperature act as nerve stimuli. The result of bringing water, higher or lower in temperature, into contact with the body is a modification of the quality of innervation at point of contact. The sensory peripheral nerve terminations are brought into a state of increased, diminished, or altered excitability.

The result depends on the degree of difference in temperature between the skin and the water or medium employed, on the suddenness of application, the duration of its action, the extent of body exposed, the variable sensibility of the subject treated, and the simultaneous mechanical and

chemical stimulation. The effects induced are due to various continuations of these factors, and may be purely local or reflex. Secondary effects also result from the supply or abstraction of heat. Powerful therapeutic actions may be brought about by the excitation of peripheral stimuli or by their inhibition. Digestion and metabolism may by this means be strongly stimulated or depressed; the vigour and frequency of the cardiac systole may be likewise influenced, and the general distribution of the blood and local and general nutrition affected. Widely different disorders of metabolism—various secretions and excretions—undergo alteration.

Local Cooling and Heating.—The effects of the local application of cold and heat are as follows:

1. Cooling or heating of the surface in contact with the medium until the temperature is almost identical. The surface temperature is always slightly higher or lower so long as the application of cold or heat respectively be not excessive and harmful.

2. Local cooling or heating do not modify the body temperature unless the area exposed comprises a quarter of the body surface.

3. Any region of the body can be warmed or cooled to any desired temperature by the supply or withdrawal of heat for a sufficient period of time and intensity of degree.

4. Heating and cooling take place more rapidly the higher and the lower the surrounding temperature after the thermic application.

5. The promptitude and degree of reaction succeeding heat abstraction and heat supply are directly proportional to the intensity, and inversely proportional to the duration of the application.

6. Active and passive movements of the part under treatment bring about more rapid restoration of heat or cold than occurs when it remains at rest.

7. Local warming is followed by cooling of the surface, and local cooling by warming, showing the alteration of heat distribution.

8. Metabolism is retarded in cooled and accelerated in warmed tissues.

General Heating and Cooling.—There are several automatic protective agencies against the general reduction of body temperature. Chief among these are:

1. Reduction of the temperature of the surface of the body, diminishing the *heat tension* between skin and cooling medium employed, and so diminishing heat loss.

2. Diminution of circulation in the skin, and resulting collateral hyperæmia in muscular layer of the entire body. So, though the skin be cooled, the muscular tissue, supplied freely with blood, prevents too extensive chilling of internal organs.

3. The rise in temperature of muscles on the withdrawal of heat is induced not only by collateral hyperæmia, but also by reflex thermal influences. While cold causes contraction of the cutaneous vessels, it induces dilatation of the vessels of the muscular layer.

4. The hyperæmia of the muscles tends to increase thermogenesis in the tissues.

It will thus be seen that the muscular layer of the body, by both storing and generating heat, is a most powerful agent in protecting the internal organs from excessive cold, and is in turn protected by the skin covering it.

Physiological Reaction after Hydrotherapeutic Procedures.—The intensity of the reaction occurring after any bath or thermal application, while partially dependent on the character of the procedure, varies greatly with the individual. To produce a proper degree of reaction after all forms of treatment is most important, and depends on the suitable adjustment of the stimulation to the individual, for the rapidity with which heat is restored after heat abstraction varies immensely in different cases. It is especially important in treating any case that the elevation of temperature of reaction following heat abstraction be carefully controlled. It is often requisite to diminish or increase its rapidity or degree. The proper restoration of heat depends on:

1. The degree of heat abstraction, *ceteris paribus*; the greater the abstraction, the more extensive the rise of temperature in reaction.

2. The time taken in the process of heat abstraction. Gradual heat loss leads to a gradual reactive process.

3. The body temperature prior to the heat abstraction. If previous heating be applied, a better and quicker reaction is obtained.

4. The application of friction and other forms of mechanical stimulation hastening the reaction.

5. Exercise subsequent to heat abstraction quickening the outset of reaction, as does also the internal administration of stimulants such as alcohol and hot coffee.

6. The heat abstraction not being carried to excess, for in that case the reaction may be much delayed or incomplete.

Baruch's Test for Reactive Capacity.—The response of the cutaneous circulation to mechanical stimuli is an index to the probable reactive capacity of the patient. "Passing the back of the nail of the index finger rapidly but gently across the surface of the abdomen, and increasing the pressure of the nail with a parallel second stroke, induces more or less reddening of the irritated skin. The rapidity with which the red line develops after the nail is removed, and the pressure required to produce it, give a fairly correct test, to the trained observer, of the patient's reactive capacity."

If good effects are to follow the application of hydrotherapeutic processes, a perfect and complete reaction is essential. We may desire to modify its character in various ways to induce a slow or quick reaction, but an incomplete reaction is never beneficial or desirable. It is characterized by lassitude, pallor, poor pulse, a chilly feeling, "cold water down the back," shivering, etc. If repeatedly occurring, it will seriously disturb the patient's health.

The beneficial effects of the hydrotherapeutic procedures only resulting when a good reaction is obtained, thus intensifying the natural defensive powers of the organism, it follows that in enfeebled individuals it is necessary to take all precautions to bring about a complete reaction, and so insure the maximum amount of good from physical remedial measures.

The automatic protective measures against heat are:

1. Dilatation of the cutaneous vessels and acceleration of the circulation through the skin and subcutaneous tissues.

By the application of heat to the skin the cutaneous vessels are dilated, the circulation is accelerated, the secretion of the skin is increased, and sweat is evaporated from the surface. Heat loss is thus effected, and the blood circulating in the skin cooled. It returns to the internal organs, and thus prevents their becoming overheated.

2. If heat application be prolonged, a large amount of blood will be retained in the skin in consequence of the loss of tone in the skin vessels; the cutaneous circulation is *slower*, and the overheated blood prevented from returning to the internal organs, to their hurt.

3. The blood being diverted to the skin, a diminished amount of blood will remain in the internal organs, and their activity be accordingly renewed. Excessively rapid penetration of heat to internal organs is thus prevented, and unduly rapid elevation of body temperature checked.

Heat Regulation, or Thermotaxis.—As a result of the stimulating effects of cold, there first occurs contraction of the skin and its vessels, which by restricting heat loss leads to perfect compensation if the abstraction of heat be slight, partial compensation if heat loss be marked. In the latter case the body temperature will continue to decline in greater or less degree; in the former it will remain constant. Alterations in thermogenesis depend on tonic and clonic muscular contractions (*i.e.*, muscular tension or tremulous movement) that occur involuntarily (*i.e.*, shivering) as the result of severe cold, just as they do in consequence of other sense irritations. These are less important as a thermotactic measure than the contraction of skin, for they cannot prevent reduction of body temperature.

Physiological Effect of Heat.—Primarily, heat acts as a stimulant or excitant. The activity of cellular protoplasm is increased, whether the cells be leucocytes, lymphocytes, or nerve or muscle cells. Such increased activity is but temporary, however, and secondary depression follows as the inevitable reaction. This reaction is due to increased heat production and lower blood-pressure. When cold is applied to the body—in moderate degree—heat production is increased, cardiac contractions are stronger, and blood-pressure is raised. Heat is therefore primarily an

excitant and secondarily a depressant, while cold is the reverse.

The effect following the application of heat depends on the form, duration, and temperature of the application, but also largely on the condition of the patient. High temperatures are first excitant and then depressant, the degree of depression being in proportion to the length of the application. After a brief one the depressing effect may be insignificant. Applications of moderate temperature are followed by a less degree of excitement and depression.

The abstraction of heat causes increase in metabolic activity only if voluntary or involuntary muscular contractions occur at the same time. So long, therefore, as the temperature in the muscle layer is increased, and remains increased in spite of heat loss, the stimulation induced thereby will lead to increase of heat production, and this constitutes an important factor in heat regulation. Further, exercise so strengthens the heat-regulating powers of the body that they are rendered capable of compensating most completely the supply and loss of heat.

The functions of the skin control heat loss, voluntary or involuntary; muscular contraction and change, in turn, control thermogenesis. And each of these can be increased or lessened at will by thermic or mechanical influences.

General Effect of Hydrotherapeutic Applications.

General Effect on Metabolism.—The general application of heat, after raising the body temperature, causes increased oxidation and excretion of CO_2. The blood is rendered more resistant to morbid influences by the increase of alexins, and on this basis rests the belief that the elevation of temperature in the exanthemata and various inflammatory disorders is merely a protective measure, and is, indeed, remedial. The application of a fomentation or poultice to any inflamed region hastens repair by inducing increased flow of blood and causing a local leucocytosis. Cold increases oxidation and elimination of CO_2, and, the body temperature remaining constant, heat produces a

reverse effect. The greater the thermic nerve stimulus, the greater will be the reflex increase in metabolism.

Systematic abstraction of heat causes secondarily an increase in body temperature, leading to the modification of the metabolic processes such as occurs in all febrile conditions. The reduction of the body temperature of a normal person by cold application will lead to a reactive process which tends to take the temperature back to the normal, or even above it. Repetition of such application produces in normal healthy people an increased reactive capacity, and a tendency to rise rapidly to the normal temperature.

Action on the Skin.—Contraction of the smooth muscle fibres of the skin is caused by brief application of intense heat, and "goose flesh" results. By prolonged application the sweat glands are excited, and the amount of perspiration may be increased twenty-fold. Marked hyperæsthesia is caused by temperatures of over 50° C. Primary pallor of the skin quickly changes to redness as the cutaneous vessels dilate, and with the reaction later pallor returns.

Action on the Muscles and Muscular Tissue.—Increase and diminution in tension of all muscle tissues are induced by the application of thermic or mechanical stimuli, both voluntary and involuntary muscles being affected. The application of cold, and of massage or friction, increases the tone in all voluntary muscle tissue. The muscular tissue may simply be increased, or clonic or toxic spasm induced. There is increased production of heat, and of capacity for withstanding fatigue. Temporary application of heat will produce similar effects, but if prolonged this leads to fatigue and weakness, and lessens heat production.

Muscular energy is increased by brief hot appliances; relaxation results from longer applications. Practically we utilize this latter action in relieving cramp of a muscle, or of the stomach or intestine.

Action on the Nervous System.—Reflex excitement of the nerve centres is induced by brief applications of heat; exhaustion follows if they are prolonged. By warm or hot applications nerve sensibility is subdued, and a comfortable sensation induced, without depression or lassitude.

Effect on Blood Constitution.—The application of cold to the body surface usually induces a varying degree of leucocytosis and increase of erythrocytes, while the colour index also rises. The leucocytosis may amount to 18,000 or 20,000; the erythrocytes may increase by 1 or 1½ millions, and the hæmoglobin often by 12 or 15 per cent. These effects are usually obtained within an hour. The increase is only temporary, however, being comparable to the physiological increase in hæmoglobin occurring after an ordinary meal. Active muscular exercise has a very similar effect. If a good reaction be not obtained these effects are not produced, but, on the contrary, there may be a diminution in the number both of erythrocytes and leucocytes.

Warm fomentations and poultices cause a local increase in the leucocytes and a diminution in red cells, while warm sitz baths cause a general reduction in both types of cells as well as in hæmoglobin percentage.

Winternitz considers there is a fallacy in this increased blood-count above spoken of. He points out the marked difference in composition of blood—as regards percentage of cellular elements—in a drop taken from the finger-tip and one taken from the abdominal wall. He further attributes the temporary leucocytosis, etc., to brisker circulatory conditions sweeping out into the general blood-stream leucocytes and red cells which were stagnating in various internal organs. He points out that, though the increase is only temporary in large degree, still gaseous interchange is encouraged here, oxygen being taken up and CO_2 thrown out in the respiration, and nutritive processes being heightened; while by methodical repetition of the thermic applications which lead to the temporary effect a permanent one is attained.

Action on the Cardio-Vascular System.—Application of cold at first quickens the cardiac beats, and later slows but strengthens them, whilst hot applications produce the reverse effects. There is a lengthening of the diastole, with improved cardiac nutrition. Similarly, as regards the peripheral circulation, there is a primary vaso-constriction and then vaso-dilatation. The blood pressure itself rises after the application of cold as much as 30 mm. of Hg in

many cases, and is lowered to a somewhat similar extent after application of heat. In both cases dilatation of the vessels occurs, but cold is a vasomotor stimulant.

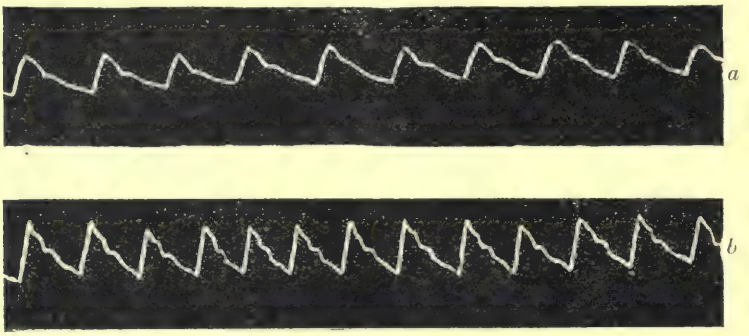


FIG. 18.—EFFECT OF COLD APPLICATION ON THE PULSE TRACING: (*a*) BEFORE; (*b*) AFTER.

While very hot applications produce a degree of cardiac excitement, the major effect is vascular dilatation and lowered blood-pressure.

Primary contraction and secondary relaxation of the bloodvessels are produced by heat, this passive dilatation

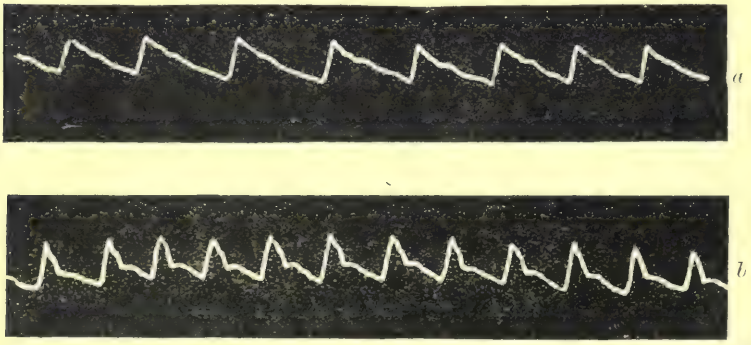


FIG. 19.—EFFECT OF HOT APPLICATION ON THE PULSE TRACING: (*a*) BEFORE; (*b*) AFTER.

causing reddening of the skin through cutaneous vessels. The effects of local applications of hot compresses, hot baths, etc., depend on the fact that, while the peripheral

vessels of any area are in a dilated, hyperæmic condition, those of the central or remaining portion are contracted, a compensatory anæmia of the region, be it internal organ or joint, resulting.

When we consider that the cutaneous vessels are capable of containing two-thirds of the total amount of blood, we are able to see how powerful an influence is exerted on blood-pressure and internal congestion by the dilatation of the whole or any part of the cutaneous "heart." The red blood-cells are diminished by the general or local application of heat, while a leucocytosis is induced. The alkalinity of the blood is lowered also. The volume of the blood is lessened by the prolonged application of heat, owing to loss of fluid by the profuse perspiration thereby induced.

Blood-Pressure.—Primarily, the effect of every hot and cold douche is to cause a rise in blood-pressure by contracting the skin capillaries, with an associated slower but more vigorous heart-heat.

Water at 35° to 40° C. causes an initial rise and then a secondary fall, with a later further rise. At a higher temperature the blood-pressure rises and pulse-rate quickens, the temperature remaining high.

If the bath involves rubbing and mechanical manipulation, the pressure goes up more, but soon falls to normal.

If the water is gaseous, as it is at Nauheim, or with artificially aerated baths at temperatures below 32° C., there is a lowering of abnormal blood-pressure; with warmer water, a marked fall. Care is thus obviously called for in dealing with patients who have diseased cardio-vascular systems and a high blood-pressure, as the immediate drop produced may be so marked as to be dangerous, and entirely upset their cardio-vascular equilibrium. Careful use of the stethoscope along with the now generally employed sphygmomanometer will prevent any untoward events of this kind, generally speaking.

Action on Respiration.—Dry heat hinders the respiratory gaseous exchange, quickening the rate of respiration, but rendering it less efficient and deep. The rate of respiration is increased by a general hot bath, and after a little the respirations are deeper in character. The skin is rendered

active, with resultant diaphoresis, but, in addition, much moisture and toxic material is thrown off by way of the lungs.

The *body temperature* is raised by a bath over 37° C., owing to interference with heat elimination. The amount of the rise will depend on the temperature and duration of the bath and the body-weight of the patient. A bath at 37° C. for half an hour, the patient being an average size male adult, will cause a rise of only 2° C. to 3° C., while if the temperature be 38° C. the rise may be as much as 1·5° or 3° C. The dilatation of the skin vessels induced by a brief hot bath will often cause a fall of temperature, owing to increased heat loss.

Action on the Internal Organs.—It is a notorious fact that the application of a *cold* bath in an abdominal examination induces rigidity of the abdominal wall, owing to increased tone of the muscles; whilst the relaxing effect of heat is frequently made use of in the reducing of herniæ and the relief of spasms, colics, etc. If, however, cold be applied to the abdominal muscles, not only are they themselves contracted, but the involuntary muscular tissue of the stomach, intestine, gall-bladder, etc., also contracts. Relaxed abdominal muscles lead to diminished intra-abdominal tension, portal engorgement, and congestion of the viscera. Gastric dilatation, indigestion, and constipation may result, with consequent malaise and malnutrition.

Blood may be diverted from any inflamed or congested viscus by the application of intense moist and dry heat to the skin surface, and the circulation through any of the viscera may be variously influenced by the alternate application of heat and cold. In this way morbid processes may be powerfully influenced and functional activity increased.

The drinking of very hot water, in sips, excites both the motor and secretory activity of the gastric wall and stimulates the circulation.

Very hot and cold applications to the epigastrium also increase both secretion and peristaltic activity. Warm applications have the reverse effect.

By hot applications to the right hypochondrium increased secretion of bile is induced, and the hepatic circulation

generally stimulated. This action is increased if a hot fomentation be followed by a "heating" compress. Distinct contraction of the spleen is effected by similar treatment.

A general hot application, sufficient to induce free perspiration, greatly relieves acute or subacute inflammation of the kidneys; a hot bath, short of perspiration, increases renal activity and promotes free flow of urine.

General Indications.—The stimulating effects of heat are utilized in dealing with conditions of extreme exhaustion from over-exertion or toxæmia. The diaphoretic effect of heat is of immense value in the treatment of many conditions—*e.g.*, acute and chronic rheumatism, severe chill, uric acid diathesis, diabetes, parasyphilides, bronchial catarrh, chronic inflammations of the gastro-intestinal tract, kidneys, or pelvic viscera.

Deep-seated inflammations are treated by means of local applications to the appropriate cutaneous surface or by general applications. In pelvic inflammation, *e.g.*, pain is greatly relieved by a hot hip pack, a general blanket pack, or hot full bath.

Toleration of Exposure to Heat.—The degree of heat which can be safely borne by a human being is dependent on the rarity or density of the medium supplying the heat, and its capacity for absorbing moisture. When a medium is very absorbent, perspiration is encouraged and scalding avoided, even when a very high temperature is employed. A full bath at a temperature of 45° C. is tolerable for eight minutes by the average European (the Japanese can take considerably hotter baths with comfort and safety). General hot-air baths of 127° C. can be borne for the same time, and local hot-air applications at considerably higher temperatures. Sweating is easy in a hot-air bath, more difficult in vapour baths, and most of all in hot-water baths.

The Basis of Hydrotherapeutic Applications.—For an intelligent understanding of the therapeutic effects of hot and cold applications one must consider the anatomical facts. The effects resulting from applications of heat and cold to the body surface depend on—

1. The general body temperature and the temperature induced locally by the application.

2. The remote changes reflexly produced by nervous influence.
3. The local vascular connections.

Nerve Reflexes.—As regards nervous influence, there are definite cutaneous reflex areas for each viscus from which the most intense reflex impressions are received.

The theory of counter-irritation is dependent on the correlation of the afferent visceral and somatic nerves, to which is also due the well-known phenomenon of "referred pain." The existence of definite cutaneous reflex areas for each viscus has been above referred to. If, from disease, a centripetal impression originates in any viscus, this induces a further stimulation in the nerve fibres coming from the corresponding segmental skin area, and gives rise to "referred pain."

The afferent visceral and cutaneous nerve fibres come into close relation in the ganglion of the posterior root, and the reflex impulse starts here or in the grey matter of the cord.

Conversely, any form of counter-irritation on the appropriate skin area in visceral disease usually acts beneficially.

Vascular Areas.—It has already been demonstrated that there is an intimate and direct relation between the visceral bloodvessels and the superincumbent cutaneous vessels. There are particularly free and ample connections with the skin surface as regards the brain, middle ear, nose, and orbit. The vessels of the lungs are related collaterally with the skin over the arms, chest, and upper portion of the back. The pericardium and parietal pleura of the interior portion of the chest are related with the overlying skin through the intercostal arteries. The posterior parietal and visceral pleura are collaterally related with the intercostal vessels. In addition, there are free connections through the inferior thyroid and the bronchial arteries, the azygos, bronchial, and intercostal veins. The kidneys are associated with the skin covering the loins through the renal branches of the lumbar arteries. There is a collateral venous and arterial relationship between the stomach, liver, spleen, intestines, and pancreas. The intimate relationship between the portal and general circulation is well known

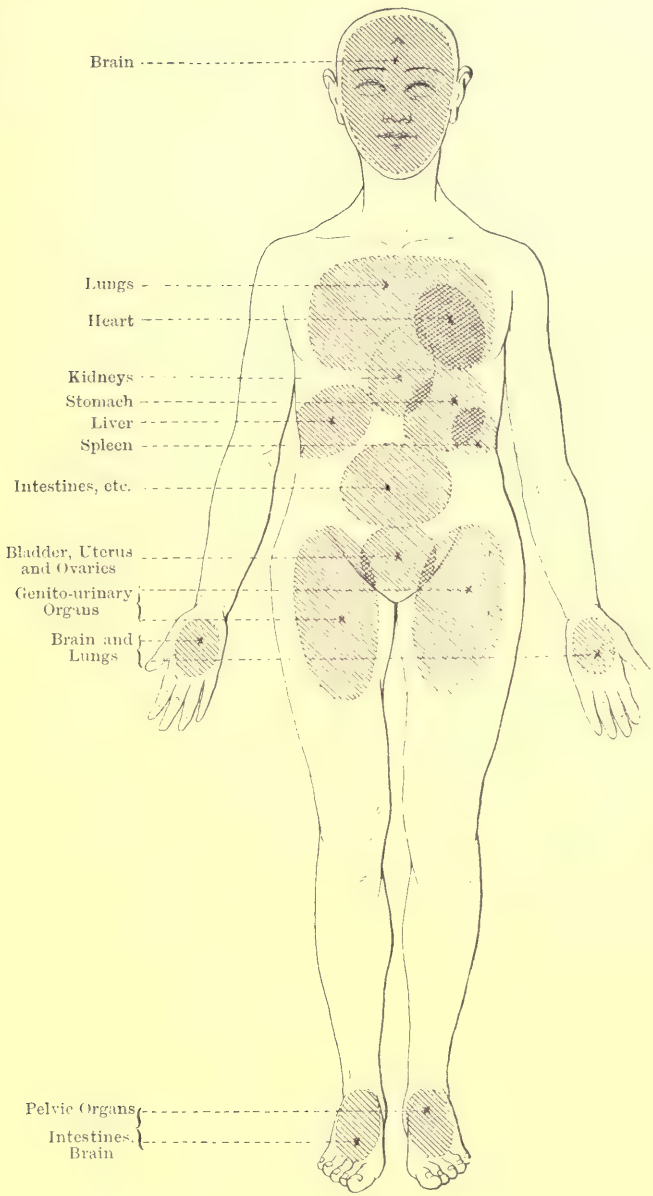


FIG. 20.—ANTERIOR CUTANEOUS AREAS REFLEXLY ASSOCIATED WITH INTERNAL PARTS.

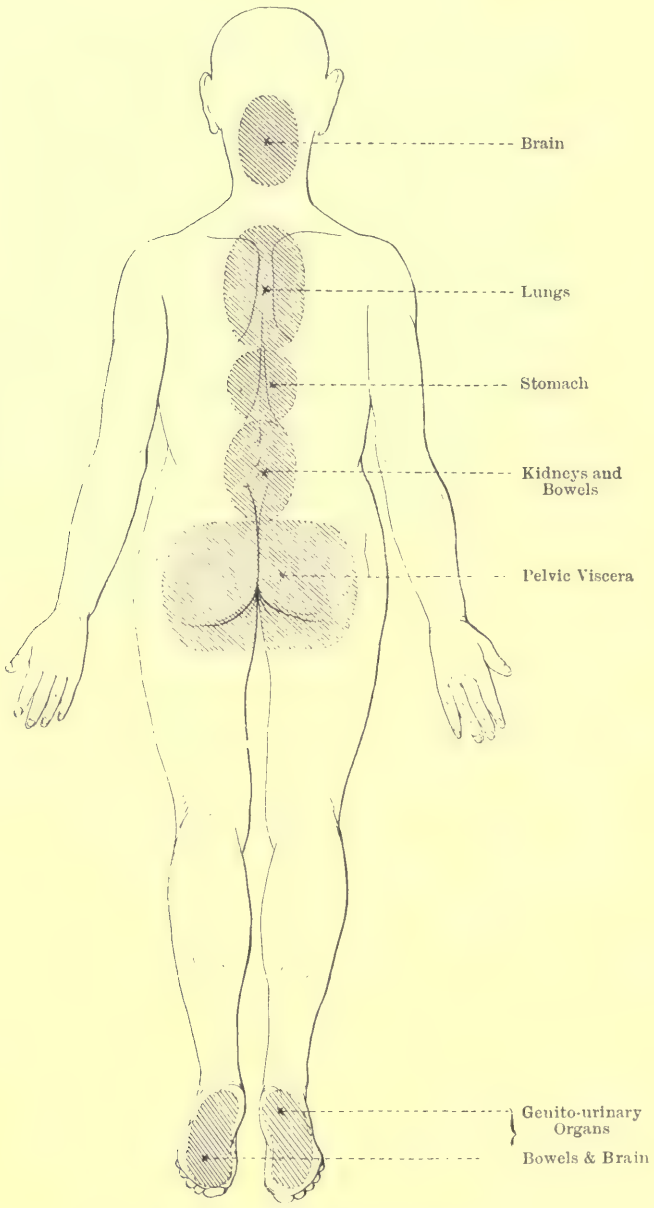


FIG. 21.—POSTERIOR CUTANEOUS AREAS REFLEXLY ASSOCIATED WITH INTERNAL PARTS.

In similar manner the upper portions of the body are related to the lower. The regions below the umbilicus are collaterally related with the head, arms, and upper half of the trunk; the legs have a close collateral connection with the pelvic viscera.

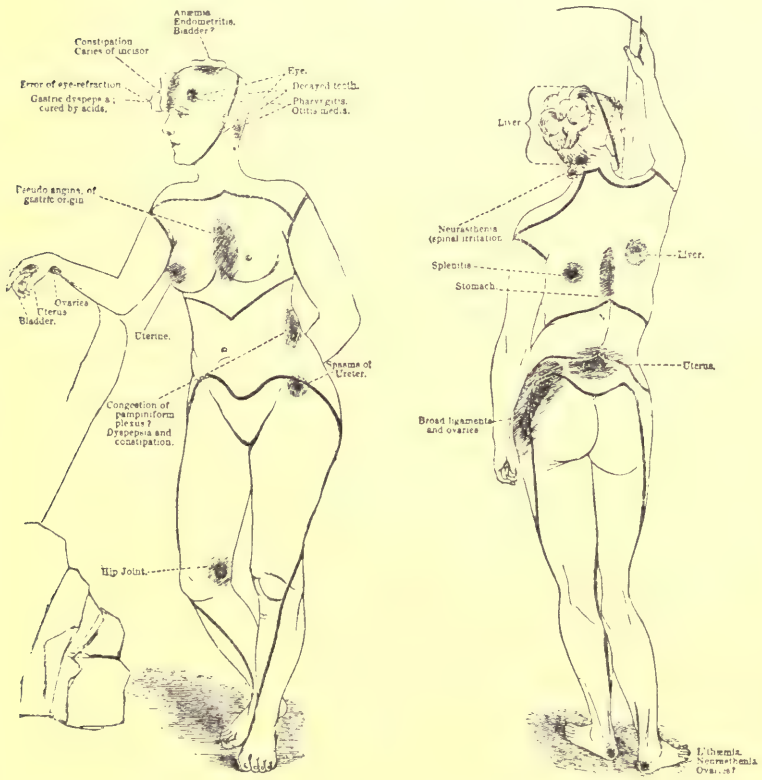


FIG. 22.—CUTANEOUS AREAS ASSOCIATED REFLEXLY WITH VISCERAL PAIN (DANA).

With these facts before us it is easy, therefore, to understand how the volume of blood in any viscus, it matters not how remote from the surface, may be diminished, either by a general hot application to the skin, or by a local application to a less extent. In this manner is to some extent explained the good effect of a hot foot bath or sitz bath on

an arterial congestion or common cold, the relief afforded to infantile croup by a hot sponge on the larynx, and the comfort afforded by a fomentation to an aching stomach or an ice-bag to a dry pleurisy.

The facts above considered constitute the scientific basis for many thermal and hydrotherapeutic applications, and for the whole practice of counter-irritation. For our knowledge of the various communications between the skin areas and the viscera dealt with above we are indebted chiefly to the work of Winternitz, Foster, and Head.

The Internal Administration of Water.

1. **By the Mouth.**—Water, when introduced into the tomach, is taken up by the tissues of the body with greater or less rapidity, and remains in contact with the tissues for a considerable period of time. It comes into immediate contact with the various portions of the digestive canal. It has a special influence on the most intimate nutritive processes by reason of its chemical constitution and the equalization of its temperature with that of the body. It further renders the tissues throughout the body permeable by all water-soluble substances taken in the form of food.

The effect of drinking a quart of cold (18° C.) water rapidly is to diminish the *pulse* frequency by 22 beats in thirty seconds; in ten to twelve minutes it becomes normal again. If the water temperature be lower the pulse declines rather more rapidly.

The temperature of the body declines with the pulse-beats to the extent of about 0·5° C., but in about ten minutes returns to the previous level.

By drinking *cold* water the temperature of the stomach is lowered considerably—to the extent of at least 0·5° C.—and the original temperature is not regained for several hours. If the rectal temperature be taken, it will be found that a lowering of over 1° C. takes place rapidly, and this lower temperature is continued for upwards of an hour. An intimate reaction evidently exists between stomach and rectum, for if a person be given a large cold-water enema,

the temperature of the stomach declines nearly 1° C. (Winternitz).

It is thus evident that the body temperature can be influenced by the imbibition of water, and, further, the temperature of various deep-seated organs can also be influenced. There is a sound basis furnished for the prescribing of systematic water drinking, and the marked local and general therapeutic effects obtained are explained. It must be borne in mind that the vasomotor system also has considerable influence.

The rapidity with which *the absorption of water* takes place depends on a variety of circumstances. The lower the blood-pressure at the moment of taking the water, the more rapidly will it be absorbed into the bloodvessels. After considerable fluid loss from the body owing to normal or pathological causes—such as free diuresis, profuse perspiration, diarrhœa, or bleeding—rapid absorption of fluid from the intestinal tract will take place.

Pure spring water, containing little saline matter, is more rapidly taken up by the blood-stream than water containing much saline matter. A carbonaceous, gaseous water is more grateful to the stomach, and more rapidly absorbed, than a still alkaline water, which may cause gastric discomfort and "fulness," even if drunk in small quantity.

After free consumption of water the blood is somewhat diluted temporarily, and the blood-pressure rises. The larger the quantity of water drunk, the greater and the more enduring is the effect on the blood-pressure, which does not, however, continue for above three and a half minutes. The increase of the water in the blood can only be demonstrated for a very short time. In less than an hour the blood has regained its former density. In one hour water which has been imbibed begins to appear in the tissues, and, normally, the entire amount is eliminated in three and a half hours. Large quantities are relatively more rapidly eliminated than small quantities. It follows that such a condition as hydræmic plethora is an impossibility, even when excessive quantities of water are consumed. Not only is this so, but the drinking of cold water acts as a diuretic, and aids in the removal of water not recently

imbibed. Warm water, while it will for a short time stimulate the kidneys to increased action, soon results in perspiration. The diuretic action of water depends not so much on the quantity actually imbibed as on the general increase of blood-pressure and freer circulation through the kidneys at greater pressure. With the increased output of water the solid constituents of the urine are also increased, especially urea and uric acid.

Method of Prescribing.—The method adopted in prescribing water will obviously vary with the effect we wish to produce.

If we desire to flood the body tissues and raise the blood-pressure, water is given in single small doses of 5 or 6 ounces, repeated every twenty minutes or half-hour for a considerable time.

On the other hand, if the object is to promote the absorption of fluid transudates, a pint or more of water should be given every six to eight hours, and all fluids withheld in the interval. Not only may the removal of dropsy or other effusion be thus greatly helped, but the absorption of inflammatory exudates is greatly accelerated.

The loss from the body is greatly increased by the free drinking of water, and, food being restricted, the blood regenerates itself from the tissues, leading to a retrogressive metamorphosis.

While moderate consumption of water, with suitable food, causes a gain in body-weight, excessive water drinking causes loss of weight.

The processes of oxidation are stimulated and rendered more efficient, as can be demonstrated by the large quantities of CO_2 eliminated and the small quantity of uric acid and kreatinins formed in the blood. Metabolism throughout the whole body is increased and accelerated.

The chilling of the stomach caused by drinking cold water (*vide supra*) evidences the undesirability of excessive drinking during meals. Apart from this, the drinking of *cold* water stimulates the liver, quickens the flow in the portal vein, and increases the secretion of bile.

2. **By the Rectum.**—Rectal injections of water at various temperatures are used for many purposes—*e.g.*, to procure

an action of the bowels, to restrain diarrhœa, to soothe pelvic pain, to get rid of intestinal parasites, particularly *Oxyuris vermicularis*, and to compensate for fluid loss from hæmorrhage or otherwise. So far as relief of the bowels is concerned, it must be clearly understood that an enema seldom accomplishes its purpose by merely washing away fæcal matter. As a matter of fact, it quite often scarcely reaches the fæcal matter, which may lie high up in the colon. It rather effects its purpose by inducing a more vigorous peristaltic action.

By the distension with water of the lower portion of the bowel a local vermicular action is started which spreads along the bowel. If the enema be too small in bulk, distension of the rectum is not effected and failure results.

The amount as well as the temperature of the water required varies greatly with circumstances and individuals. Anything from half a pint to three or four pints or more may be needed. Warm and hot enemata are more stimulating and effective than cold.

If a large injection is to be given, the patient should lie on his left side with knees drawn up, and fluid be slowly pumped into the rectum. After a varying time the patient feels unable to retain more, and has a colicky pain in the abdomen, and desires to relieve the bowels; this desire may be gratified, or, if a large enema is deemed necessary, the patient is asked to endeavour to retain the water, and helped by means of a folded towel pressed over the anus, pumping having, of course, ceased in the meantime. The desire to defæcate will soon pass off, and then more water can be introduced. It is often more convenient to use a douche-can, and allow the water to enter by gravity only. Less straining is thus induced, and by this means the patient can carry out the procedure unassisted.

When complete irrigation of the colon is desired, as many as six to eight pints may be introduced by this method; but the frequent use of large enemata induces eventually an atonic condition of the bowel, and the last state of the patient is worse than the first.

In some cases, when constipation is obstinate and long-standing, as is common in mental disease and diabetes, the

injected water may come away quite clear, and have no relieving action on the bowels. Under such circumstances, if even warm enemata do not accomplish their purpose, kneading the abdomen along the course of the colon must be employed as an adjuvant, and even actual removal of the fæces by digital efforts or a spoon may be necessary.

Where it is desired to introduce fluid to be actually retained and absorbed by the patient, the use of a long rectal tube is often an advantage.

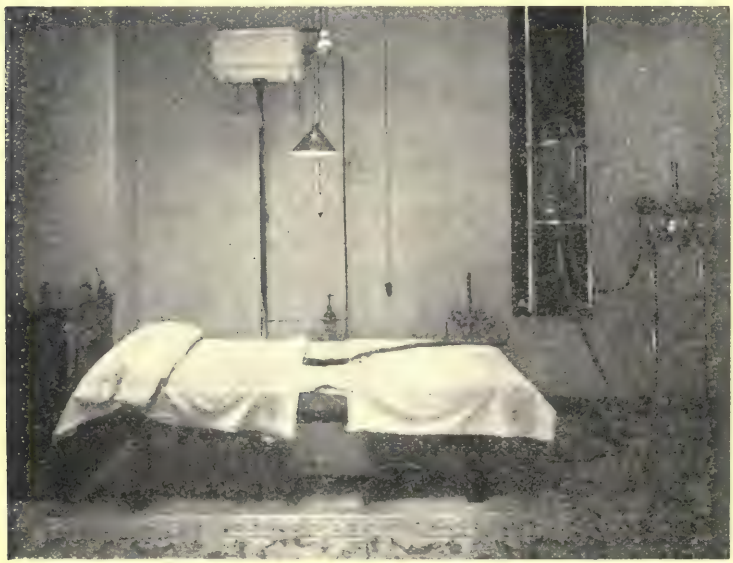


Fig. 23.—The Plombières Douche.

Warm injections often materially lessen the pain of cancer of the bowel, and relative distressing tenesmus and straining. They are also of use in cystitis, prostatic abscess, and parametritis. Irrigation of the colon for chronic mucous colitis is now very extensively employed, a special feature being made of it at Harrogate.

In gastric dilatation, etc., where it is desired to give the stomach a complete rest from fluid, the tissues may be kept properly supplied *per rectum* with great ease, and much to the patient's comfort and well-being.

The value of large injections of plain or slightly alkaline water in the condition of mucous colitis has long been known. Recently this has been done from above downwards by means of a small opening formed for the purpose in the colon by the operation of appendicostomy.

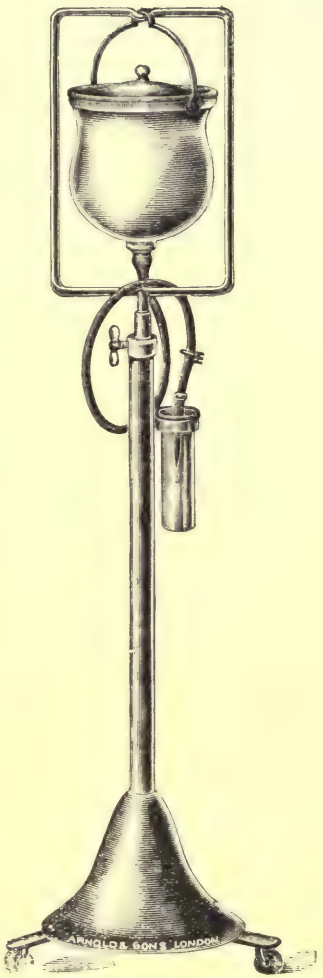


Fig. 24.—An Adjustable Gravity Syringe.

Irrigation.

Vaginal Douching or Irrigation (as Kellogg thinks it should more properly be called).—This consists in the injection into the vaginal canal of a stream of cold, hot, or tepid water, under but slight pressure.

Its value in various uterine, ovarian, and other pelvic disorders to which women are subject is generally recognized.

To obtain the best results some little attention to the details of the technique is requisite. A gravity syringe is usually employed, the water being contained in a can or glass reservoir which rests on a shelf or stool some 3 feet above the patient, or special appliances are made (Fig. 24). The water is conducted to the vagina by means of a rubber tube terminating in a glass or vulcanite nozzle. The patient lies on her back, and the water passes out of the vagina into a suitable receptacle arranged to catch it. Kellogg has devised a special form of table made of marble. The table being hollowed to fit the patient's back, and an opening provided to conduct the

water rapidly away without wetting the patient's clothing, asepsis is specially easy to maintain.

In introducing the vaginal tube, care is needed to pass it into the posterior vaginal fornix as far as possible, and thus avoid any chance of injecting the water into the uterine cavity.

The idea is to allow the water to circulate freely around the neck of the uterus and in the vagina, bringing every part under its influence. The mucous membrane is directly, and the pelvic viscera reflexly, affected.

Effects.—Both hot and cold applications are useful in relieving hæmorrhage due to uterine congestion, chronic metritis, etc. Cold water is generally more efficient in this respect than hot. Hot douches lessen, and even completely arrest, uterine contractility and excitability, which cold douching increases. Further, cold douches may cause painful uterine contractions and aggravate neuralgic uterine and pelvic pains, so that water of the higher temperatures is most commonly employed. A douche of a temperature of 32° C. is of great service in relieving pelvic congestions. Temperatures below 6° C. are practically never employed, but a douche of 25° to 27° C. is very frequently of service.

Very hot irrigations are employed to check hæmorrhage, a temperature of 50° to 55° C. being utilized. Hot irrigations of 45° to 47° C. relieve pain, and promote the absorption of exudates in parametritis and pelvic cellulitis; they are of service in chronic metritis, ovaritis, and endometritis.

For intra-uterine irrigation only distilled or sterilized water must be used.

Rectal Irrigation.—The rectal irrigator (Fig. 25), or psychrophore of Artzberger, is a faucet-like hollow instrument, permitting the inflow and outflow of water, the temperature of which will vary with circumstances.

Before introduction into the rectum, the irrigator should be well lubricated with vaseline or lanolin, and the patient —placed in a suitable posture—asked to "bear down."

The temperature of the water (which should be flowing from an ordinary douche-can at an elevation) used at the commencement should not be lower than 20° C. in most cases;

and if there be any inflammatory condition in the bladder neck, very disagreeable strangury and tenesmus may be excited.

The effect of the application is tonic, and to some extent soothing and anæsthetic. This procedure is serviceable in hæmorrhoids and in various chronic inflammatory con-

Fig. 25.—Rectal Irrigator.

ditions of the rectum and its vicinity. Hot and cold water alternately are variously employed, according to the effect it is desired to produce.

The Psychrophore, or Cooling Urethral Sound.—This resembles an ordinary two-way catheter, and is introduced in the same way. It should, however, stop short of the vesical cavity just as the sphincter vesicæ grips it. A fairly large size (Nos. 12 to 14) is generally used, at any rate after the first time. The water temperature should at first be 20° to 22° C., and reduced to 10° C. gradually. The patient

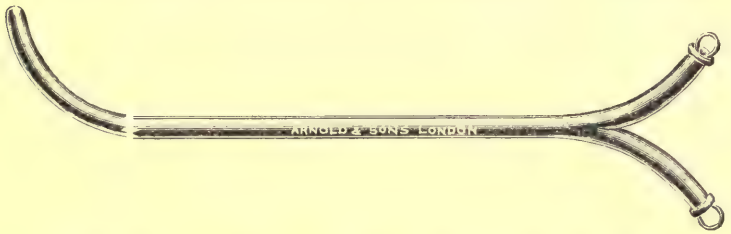


Fig. 26.—Winternitz's Urethral Psychrophore.

should be told to empty his bladder prior to the introduction of the sound. Some vesical tenesmus may occur at first, but soon passes off; the effect of the treatment is soothing and tonic. At first the sound should be allowed to remain in for about five minutes, and then gradually a longer period up to half an hour, using it on alternate days.

THERAPEUTIC INDICATIONS.—It is useful both in nocturnal enuresis in adults and in testicular neuralgia; also in atonic psychical impotence, spermatorrhœa, prostatorrhœa, and chronic gleet—a very large bore being advisable in the last affection, as first advised by Keyes.

Colon Douching—*The Technique of Irrigation, or the Plombières Douche.*—This may be done in a bedroom with an ordinary gravity douche-can and rubber tubing, but it is, of course, preferably done, as at Harrogate and other health resorts, by means of the complete Plombières outfit.

It may be carried out with a single tube, using a two-way tap apparatus or its equivalent, or by means of a simple funnel and tube, or with a double-current rectal tube.

The two-way tap apparatus consists of a douche-can and two-way tap, one arm of which is attached to the douche-can by means of a rubber tube; another terminates in stomach tube with terminal and lateral eyes; while the remaining arm enters a third rubber tube, which leads into a receptacle beside the couch or bed on which the patient lies.

The patient lies on his left side, and the end of the rubber stomach tube is passed about 4 inches up into the bowel. Water is now allowed to enter from the douche-can with about 1 to 1½ feet of "head." When enough has entered, the tap is adjusted for outflow to the receptacle on the floor.

It is well to bear in mind clearly that the water has to find its own way up to the "higher reaches" of the colon, unless the tube be very long—viz., about a yard. The rectum is 8 inches long and sigmoid 17½ inches—a point worth remembering. In place of the stomach tube special colon tubes about 10 inches long are supplied at Harrogate, made of fairly thick rubber and tapered. Each patient has his own tube.

A definite amount of fluid is allowed to enter the bowel and a definite amount allowed to leave, with a prearranged quantity allowed to remain. Every douche-can should have a graduated front of glass, and the tube of exit should pass into a large measure first.

The patient lies upon his left side with hips well raised by sandbags or similar medium, while a pint or so of water is introduced into the rectum.

The patient then gets up and evacuates the bowel, as this preliminary douche is for that purpose. The original posture is then resumed and the irrigation continued. In some cases it is requisite to employ the knee-chest position to secure the fluid passing up the bowel.

Irrigation by a double-current tube is, of course, quite different, as the fluid enters the bowel by one tube and leaves by the other. A soft double-current tube (French make) is usually employed. The irrigator is attached to two tubes, one of which is connected with the douche-can or cistern, and the other passing to some suitable receptacle below the bed or couch on which the patient is lying. Well lubricated, it is introduced into the bowel with a gentle rotatory motion, the tube being directed slightly backwards. The inlet and outlet tubes are so arranged that the amount of water leaving and entering the bowel are equal. If a certain amount be allowed to enter the bowel before any escape occurs, this will remain constant and in contact with the bowel, though always changing with the flow of the water. Fresh water or solution is thus brought into contact with the mucous membrane. The amount left in varies from a few ounces to 1½ pints or more, according to the surface of the bowel it is requisite to deal with. Kemp's instructions for irrigating the whole of the colon as far as the cæcum are as follows:

1. Place the patient on the left side with the hips elevated, and the descending colon is freely irrigated.

2. Turn the patient over gradually to dorsal position and then to the right side, with the hips elevated; pinch the return tube so that about 1½ pints are allowed to run into the bowel.

3. Raise the shoulders above the hips, patient being still on the right side. The fluid is thus made to gravitate on to the caput coli.

4. Then depress the shoulders below the hip level, turning the patient back to the dorsal position and left side—in short, reverse the first manœuvre. The return tube is then let go and the water escapes.

The temperature of the water used will vary with the state of the mucous membrane. Plain water or normal

saline is the best and safest medium to use, but various medicaments are added at times, such as tannic acid, boracic acid, permanganate of potash, ichthyol, and protargol, which last in $\frac{1}{8}$ per cent. strength we have found most useful in mucous colitis. At Harrogate the sulphur water is commonly employed.

Such irrigation should be regularly employed during the first three weeks of the treatment of colitis of chronic type. It is a very healing and soothing measure in chronic ulceration, and if there be any considerable degree of toxæmia. We have known very distressing eczema afforded quick relief by this procedure.

The elaborate Plombières couch (Fig. 23), as used at Harrogate, etc., is, of course, a refinement or amplification of the treatment, but most necessary where large numbers of patients are passed through daily. The couch used is about the size of a short single bed, and in the centre is an aperture similar to that in an ordinary w.c. seat, through which the patients evacuate the bowel after the first washing. The fæces are washed away from a grid or netting by the attendant, and the amount of mucus passed more or less estimated by the attendant, who registers it on the patient's chart. Careful note is thus kept of his progress.

Needless to say, many patients cannot have such an equipment readily available, and with these quite adequate douching can be carried out with the gravity douche-can at home.

The immediate effect on patients varies. Many feel quite fresh and brisk at once after the treatment and capable of taking exercise, but the more feeble are inclined to feel collapsed and require a prolonged rest to regain their equilibrium.

At a large spa there is often a rush for appointments, and early appointments even before breakfast may be necessary. Such times should be avoided except by those who are robust.

CHAPTER II

ON THE TAKING OF BATHS

THE technique of hydrotherapy has reached a very high degree of development, and such a variety of baths are employed at the present day, and there are so many modifications of them, that it is now possible to adapt special hydriatric procedures to each individual case coming before us for treatment.

In every variety of bathing procedure the points of the highest importance are the temperature of the water applied, the amount of pressure under which it is applied, the friction produced, and the duration of the application. By varying these, the same effects can be produced by very different methods. Winternitz lays great stress on the importance of the measure of stimulation in each.

It is customary to cool the head thoroughly before every cool or warm application, and to keep it wrapped up in some cool covering during the whole of the process. This helps to prevent ill effects through the blood being driven inwards by the cooling of the skin surface, and inducing what Winternitz calls "retrograde hydrostatic congestion" of any of the internal organs, but more especially the brain.

If a hot application be used, cooling of the head is also desirable; for here again internal congestion is caused, and in old and plethoric patients there is a tendency to apoplexy.

It is of course essential when any bath is ordered by a physician that a specific statement be made as to the temperature of the water to be employed and the duration of the application.

General Precautions as to the Taking of Baths.

1. A careful examination of the cardio-vascular system should be made before the physician prescribes any bath or set of baths.

2. Extreme temperatures are specially undesirable in children and elderly people, and also in women at the time of the climacteric. During the catamenial flow hydriatric procedures should for the most part be suspended.

3. Every bath has an effect which is either stimulant or sedative; which of these predominates will depend on various circumstances, such as the range of temperature and duration of the procedure, also the time of the day and general condition of the patient.

4. Care is very necessary not to prolong thermal baths sufficiently to cause depression or lassitude.

5. Hot-air and vapour baths should never be employed in febrile conditions, unless in incipient catarrhal conditions and chills.

6. Too stimulating procedures or a prolonged course of treatment are often followed by circulatory depression and considerable debility.

7. In chronic diseases, during the first week or two of treatment there is often some exacerbation of symptoms, which is not an unfavourable sign, and passes on into healthier conditions.

8. Physical exercise usually requires some modification during a course of bathing, etc. The reaction of the cooling processes is hastened and assisted by a short brisk walk; rest and cooling are frequently beneficial after warm applications. If much exercise be taken during a full course of treatment, loss of weight will result.

9. After a course of hydrotherapeutic treatment, a change to a more bracing climate, or a short sea trip, is often beneficial. This constitutes what is known on the Continent as the "after-cure." Patients who feel exhilarated by their better health should be warned not to overexert themselves and so induce a relapse.

The Technique of Baths—Partial and General.

The Arm Bath.—This is chiefly used in surgical cases, in severe burns and skin diseases (Fig. 28), and requires no detailed notice here.

The Foot Bath.—The bath itself is a familiar household utensil, made either of metal, porcelain, or wood, and requires no further description (Fig. 27). There are, however, many varieties of application of the bath so far as the temperature and duration are concerned. The following are the most important:

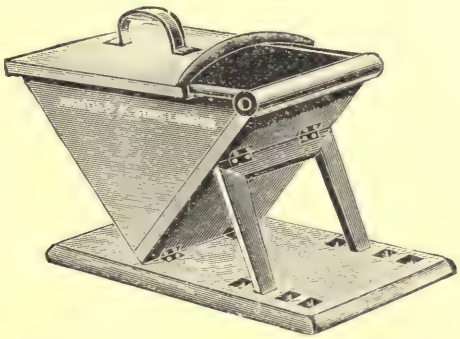


Fig. 27. -An improved Foot Bath.

1. *Cold.*—Two inches deep, for thirty minutes, the feet to be kept on the move all the time and rubbed against each other. The action of the bath is intensified if the water is flowing through the vessel used, and thus constantly changing and always at the same temperature. Water of a temperature of from 10° to 15° C. is commonly employed. At the conclusion the feet should be well dried, and the patient take a short walk.

This bath is a powerful derivative, inducing a hyperæmia in the vessels of the feet and legs. It helps to relieve congestion of the brain and viscera, and is of high value in cases of habitually cold feet. The general effect is tonic.

Caution.—This bath should not be used, nor indeed any cold foot bath, in any bladder, rectal, or ovarian inflammation, nor in sciatica.

2. *Treading in cold water,* 1 inch deep, for two to three minutes. This is a useful measure in cases of cold feet from poor circulation, and, given at bedtime, for insomnia.

3. *Cold sponging* of feet and legs over a bath, one limb at a time, for two or three minutes. The feet should be well rubbed with a rough towel until quite dry, and a brief quick walk taken. The action is similar to that of Nos. 1 and 2.

4. *Alternate Hot and Cold.*—Two foot baths are placed side by side, one containing hot water at 38° C., and the other cold at 18° C. The patient's feet are placed in the hot water for half a minute, and then shifted to the cold for a like period; the process is repeated several times, the whole bath lasting from seven to ten minutes, and finishing with cold water. This is a very stimulating form of the bath, and is useful in chilblains, in early Raynaud's disease, and in habitually cold and sweating feet.

5. *Hot.*—Water at a temperature of 40° to 50° C. is employed, beginning at a temperature of 40° to 42° C., and gradually increased. The feet should be completely immersed—indeed, the deeper the water the more intense the effect. The patient sits with a blanket or sheet enclosing the bath and limbs as high as the waist. The duration of the bath is from ten to twenty minutes, rarely prolonged to half an hour. At the conclusion the feet and ankles should be sponged with cold water and briskly rubbed until dry.

6. *Very Hot.*—Water up to 51° or 52° C., as hot as can be borne, is used, the temperature being maintained by pouring a cupful of boiling water against the side of the bath every two minutes, as much water being removed in advance; the wrappings should be as little disturbed as possible. Duration, twenty minutes.

7. *Mustard.*—A breakfast-cupful of mustard bran or tablespoonful of table mustard is used for each quart of water—of a temperature of 48° to 52° C.—as hot as can be borne. Duration, fifteen minutes, or less if uncomfortably hot.

The ultimate effect of all these baths is to render the brain anæmic and quicken the pulse-rate. The hot foot bath is *par excellence* a derivative measure, relieving brain

FIG. 28.—THE ARM BATH.

FIG. 29.—THE LEG BATH.

FIG. 30.—THE FOOT BATH.

and visceral congestions. At the same time the vascular activity of the pelvic viscera is increased, and by means of these baths delayed or suspended menstruation may often be brought on. The value of a hot foot bath at bedtime in incipient coryza is well known, its action being intensified if it contain mustard. Whitla also recommends this in any congestive headache. It is also of great value, combined with elevation of the hands, in epistaxis.

The Hand Bath.—Immersion of the hands in cold water exercises a much more powerful influence on the pulmonary and cerebral vessels than would be naturally expected (Kellogg). The pulse is slowed and the pressure in the brain arteries lowered by the use of a cold hand bath, while the opposite effect is induced by a hot hand bath.

In epistaxis the bleeding is readily checked if both hands be completely immersed in cold water, or a piece of ice be held in the palm of the patient's hand. In the same way pulmonary hæmorrhage may be beneficially influenced.

There seems to be some reflex connection with the genito-urinary organs also, for the fact that placing the hands in cold water often causes the desire for micturition is well known.

The Head Bath.—The head of the patient should rest comfortably on the rim of a suitable vessel, charged to within an inch of the brim with water at a temperature of 27° C., which is continuously taken up and poured over the patient's head by means of a breakfast cup. After fifteen or twenty minutes of this, the vessel is slipped away and the head held up by the hand. A towel is laid loosely over the hair and another is laid on a pillow on which the head is now rested. The patient is left thus for half an hour or more, if agreeable.

Some little modification is required in the case of women, on account of their usually long hair. The face only should be dipped into the bath, or if the whole head be dipped, special precautions will be required in drying, and the patient should stay indoors for some hours with the hair wrapped up in a silk handkerchief.

The patient lies on his back, with the shoulders raised by pillows to the level of the edge of the bath, from the sharpness of which the back of the neck is protected by means of

a pad. The feet and legs are well covered up, with the addition, if necessary, of a hot-water bottle.

Should a regular head bath not be available, an ordinary washstand basin with an inverted soap-dish in the middle, and capped with a sponge, will suffice. Comfort in position is essential, and care should be taken to avoid haste in rising from the supine position.

By means of the head bath anæmic headaches are often relieved and sexual excitement allayed. Hughes Bennett recommended this bath in delirium tremens.

Simple head bathing for a very few minutes is often of service in a feverish or congestive headache, or in the headache due to exposure to the sun. The brow and temples are sponged with cold water (18° to 20° C.) for two to three minutes, the patient stooping the while over the basin of water.

The refreshing effect of the application of a cold sponge or wet napkin to the posterior auricular region is well known to the epicurean. The mental obfuscation induced by a good dinner and the accompanying wine is thus quickly removed, hence the name of "the alderman's nerve" applied to the posterior auricular.

The headache of coryza and the feeling of stuffiness in the nose is relieved if the forehead and nose be sponged with water as hot as can be borne for a couple of minutes.

The Leg Bath.—A deeper vessel is used for this than in the foot bath (Fig. 29), and the temperature of the water will vary according to the effect desired.

Hot Leg Bath.—Water 37° to 45° C. for ten minutes, followed by tepid sponging. Mustard may be added to enhance the effect if there be no contra-indication.

Cold Leg Bath.—Temperature 10° to 15° C. for ten minutes.

The Sweating Leg Bath.—The bath figured above, or a deep pail, is filled to within 3 inches of the brim with water at 37° to 38° C. The patient is undressed and seated on a chair covered with a warm flannel pad, with his legs in the bath. He is completely enveloped in a blanket previously warmed. The temperature of the water is gradually raised by pouring a pint of boiling water into the bath every two

minutes—against the side of the bath—a similar amount having been removed in advance. The temperature should be raised as high as the patient can bear—about 45° to 47° C. —and the bath continued for twenty minutes. The patient will perspire profusely. At the conclusion he is dried lightly with warm rough towels and put to bed between blankets, sweating being encouraged by means of extra bed-clothes and hot drinks.

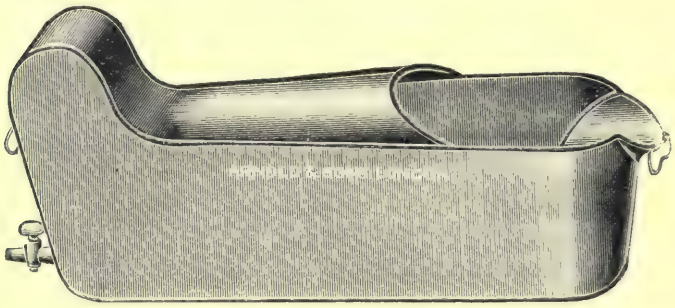


FIG. 31.—AN IMPROVED LEG BATH.

This bath is an extremely handy, inexpensive, and readily procured sudorific and derivative measure. It is always of service where diaphoresis is indicated and the more elaborate and modern methods and apparatus are not available. It is useful in suppressed menstruation, in dysmenorrhœa, and ovarian congestion.

The Sitz Bath.—The ordinary sitz or hip bath is too well known to need much detailed description. It may be made of porcelain, metal, or wood (Figs. 32, 33, 38).

The best form of bath known at present is probably that of the Fischer Kiefer Co., which is made of plated metal with an automatic self-emptying arrangement, which maintains the water at a constant level. The male sitz bath usually measures 20 inches by 15 inches in breadth, and has a nearly straight back. The female sitz bath is usually narrower across the brim, in order that the clothing of the patient may be kept out of the water, and undressing be avoided if so desired. A hot-water can or tub is usually placed at the patient's feet and a wet cloth around his head while the bath lasts (Fig. 32). The water

should reach to the level of the patient's umbilicus, and about 5 or 6 gallons are usually required.

If the bath is of anything but the briefest duration, the patient should be carefully protected from cold by means of a blanket, which encloses the whole bath, with his feet and legs.

The temperature of this bath will vary from 10° to 45° C., and will depend on whether we desire it to be cold (10° to 20°), tepid (20° to 30°), warm (30° to 38°), or hot (40° to 45°). Many people will be unable to stand anything over 42° C. The duration will vary from two to thirty minutes.

Fig. 32.—Sitz Bath, with Friction.

Kellogg considers that the flexion of the limbs entailed by this bath interferes with its efficacy by restricting the circulation.

Modus Operandi.—The action of this procedure depends on the temperature of the water and the time for which it is kept up. The pelvic and abdominal viscera are reflexly stimulated: a cold bath of any duration causes them to contract, while a hot bath causes dilatation. In the reaction

after a cold bath dilatation in all probability ensues, but the effect of the cold lasts for some time and induces anæmia of the viscera.

Intestinal peristalsis is stimulated by brief cold baths, but long-continued cold baths lessen peristalsis.

Varieties of the Sitz Bath—1. *Cold Sitz Bath.*—The water should cover the groins and no more. Wrapped in a blanket, the patient remains in it for ten minutes, the attendant rubbing the back and abdomen if at all chilly. It is not necessary to undress completely, but only sufficiently to keep the clothing out of the water. The patient is carefully dried, and should take a short sharp walk to get thoroughly warm.

2. *Tepid.*—27·5° for ten minutes, with a little cold water run in at the finish.

3. *Flowing.*—Cold water is kept running through the sitz bath all the time. Duration, two minutes, or less if the cold be felt too keenly.

4. *Dipping.*—The bath contains cold water 3 inches in depth, and the patient keeps moving up and down all the time. Grasping the sides, he rises clear of the water and then sits down again, and does this every second or two for two minutes.

5. *With Water as Hot as can be Borne.*—The bath is full of water at about 38° C., and a foot bath of the same temperature is placed in front of it. Hot flannel pads are placed, one on the back of the bath and the other floating in the water. Completely undressed, the patient sits down, and is enveloped from head to foot in warm blankets. A cold, wet cloth is wrapped around his head. A minute after, a pint of boiling water is poured gently against the side of the bath (as in the sweating leg bath), removing as much beforehand by means of a cup or the overflow pipe. The wrappings must be disturbed as little as possible. Add boiling water thus every minute until the bath is as hot as can be borne (44° to 46° C.). After twenty minutes have elapsed the patient gets up from the bath, is carefully dried with hot towels, and put in bed between blankets. The room in which this bath is given should be comfortably warm.

6. *Hot and Cold Alternate by Gradual Transitions.*—Begin with 38° C., and raise the temperature as high as can be borne (43° to 46° C.). Then slowly reduce as before, taking about two minutes for each change, and ten minutes in all for the bath. The patient's clothing is entirely removed.

FIG. 33.—ASCENDING DOUCHE FITTING FOR PILES AND PRURITUS ANI, PROLAPSUS, ETC.
Temperature varies for each case.

7. *Hot and Cold Alternate by Sudden Changes.*—Two sitz baths are used side by side, one containing water at 18° C., and the other hot water at 42° C. The patient moves from one to the other every two minutes, beginning with the hot and ending with the cold water. The bath is continued for eight or ten minutes.

8. *Warm Sitz Bath with Cold Affusion to the Abdomen.*—The patient is seated in water at 38° C., with the bath full to the overflow pipe. A pint of cold water (18° C.) is poured over the lower part of the abdomen every two minutes from a height of a foot or so. The surface of the abdomen is rubbed all the time, either by the attendant or the patient himself. The bath concludes with cold sponging of the parts, and lasts for ten minutes.

9. *With Mustard.*—This bath is the same as No. 5, only a tablespoonful of table mustard or a cupful of mustard bran is added to each gallon of water.

Therapeutic Indications.—Cold sitz baths of from two to five minutes' duration are indicated in various abdominal and pelvic diseases and affections, such as ovarian and uterine neuralgia, chronic prostatic congestion, and bladder atony; in chronic gastric catarrh, chronic intestinal catarrh, and hepatic congestion; in constipation, amenorrhœa, and sometimes in spermatorrhœa and impotence. Although the cerebral activity is often markedly increased, in some cases of insomnia sleep is induced by this procedure.

Care must be taken never to use cold sitz baths in any acute inflammatory condition of the abdominal viscera or in cystitis.

Prolonged cold sitz baths from three to eight minutes exsanguinate the intestinal surface, and are useful in various diarrhœas and dysentery, in piles and proctitis, chronic menorrhagia and pelvic congestion (especially if combined with hot vaginal douches).

Warm sitz baths from twenty minutes to one hour in duration have a sedative and anodyne effect, and are useful in acute and chronic inflammatory conditions, in constipation, and the anæmia often associated with it.

The hot sitz bath is useful in restoring suspended menstruation, in vaginismus and ovarian neuralgia. In renal colic, neuralgia of the testicles, sciatica, tenesmus, and any painful non-inflammatory affections of the pelvic or lower abdominal viscera it is indeed a powerful analgesic. The mustard sitz bath is at all times a derivative, and it is often employed effectually in amenorrhœa.

The cold sitz bath produces a profound effect on all the

FIG. 34.—GENERAL BATH AND DOUCHE ROOM.

FIG. 35.—SITZ BATH, NAUHEIM BATH, AND PACKING COUCH.

FIG. 36.—THE HALF BATH WITH AFFUSION.

FIG. 37.—THE HALF BATH WITH FRICTION.

FIG. 38.—THE SITZ BATH.

FIG. 39.—BACK LAVING OR SPONGING.

bodily functions. There is lessened activity of the skin, "goose flesh," contraction of the cutaneous vessels, and slowing of the pulse.

A hot sitz bath acts as an anodyne, antispasmodic, and derivative measure. The pelvic circulation is increased, and blood diverted to the pelvic viscera.

The Back Laving.—The patient, partially dressed, or covered with a blanket, sits across a sitz bath half full of cold water, while the attendant with a sponge laves the entire spine for five minutes with—

1. *Cold Water.*—If the clothing be removed, the patient should be carefully covered up in front by means of a specially made blanket (Fig. 39).

2. *Tepid to Cold.*—At 27° C. for four minutes, and cold for one minute.

3. *Hot and Cold Alternate.*—The water is run gradually from warm (32° C.) down to cold, and then up again to as high a temperature as can be borne (46° to 47° C.), and once more down to cold. The back is laved for five minutes in all.

4. *Hot and Cold Alternate, with Rapid Changes from Hot to Cold, each for Half a Minute.*—This is done by having a couple of cans or buckets side by side, with hot and cold water, and using a separate sponge for each. Duration, five minutes in all.

5. *With Mustard.*—A breakfast-cupful of mustard bran (or a tablespoonful of table mustard) is used to each quart of water, which should be as hot as the patient can bear it. Duration, four minutes, or less if felt too acutely. The bath is finished with cold water for fifteen seconds.

The Back Spouting—1. *Cold.*—A jet of cold water is played up and down the whole length of the patient's back, the patient being partially undressed and seated on a board placed across the sitz bath. One minute will suffice.

2. *Warm to Cold.*—Begin at 32° C., and run gradually down in the course of a minute to cold, at which it is continued for two minutes or more.

3. *Hot and Cold Alternate.*—Hot (45° C.) at first for half a minute, then cold for half a minute. Keep changing from one to the other for three minutes, and then conclude with cold.

These are all tonic bracing applications. The hot and mustard applications are best suited to the old, and patients with feeble circulation. The back spouting is only adapted to the more vigorous type of patients.

The Half Bath.—An ordinary shallow household bath is used, about half full of water from 20° to 30° C., according to the effect we desire to produce. After cooling his head with water, the patient enters the bath and sits down so as to be about half immersed. He lowers his body for a moment so as to immerse the shoulders, and then returns to the sitting posture, while an attendant freely douches

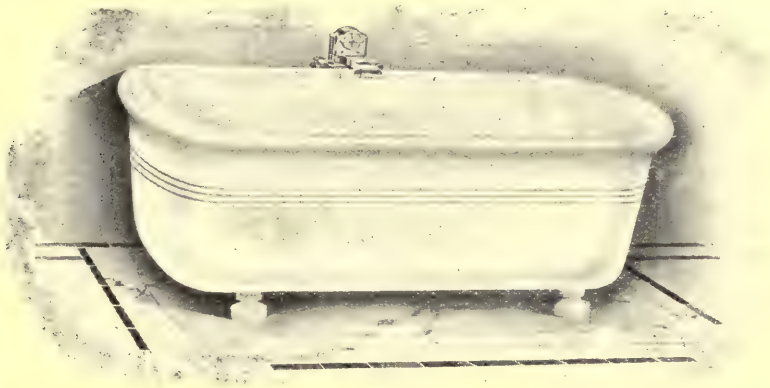


Fig. 40.—Modern Type of Set-in Bath.

the upper portion of his body. He again lowers himself into the semi-recumbent position while the attendant briskly rubs the chest, abdomen, and limbs with bare hands or friction gloves (Figs. 36, 37). The bath is then completed, and the patient wrapped in a warm sheet and dried.

This bath is stimulating, and a good reaction is encouraged by the friction movements; generally speaking, the warmer the temperature of the water, the less the stimulating effect of the bath. The quicker the reaction, the greater is the amount of heat abstracted.

This bath is of great service as an antipyretic, but

should not be used for more than a very short period where the patient is weak and collapsed. In such cases it is well to give the patients a warm and even stimulating drink immediately before the bath is administered.

INDICATIONS.—Cool baths (22° to 26° C.) of three or four minutes' duration may be used regularly in the morning as a hygienic measure for people in ordinary health. They may be combined with friction, and are exceedingly pleasant and refreshing.

In diseases of digestive character, such as gastric irritation, or atony, or hyperchlorhydria, this bath, combined with hot and cold douching to the abdomen, is exceedingly helpful and beneficial. The douching can be carried out by the patient himself by means of a tin basin, or more efficiently by an attendant.

In affections of the spinal cord, etc., the temperature of the water should be from 28° to 30° C. If the lesion be an irritative one, such as ataxic paraplegia, chorea gravis, or paralysis agitans, the water may be even warmer with advantage. In myelitis and other paralytic conditions a brief cool bath is best.

The Use of the Half Bath in Typhoid and Other Fevers.—Although scarcely within the scope of this work, it may be well to allude briefly to the extreme value of the cooling bath in typhoid, as advocated by Brand, Barr, and others.

The Plunge Bath.—The temperature of the water should be cool or cold, from 22° down to 15° C. The duration, one to three minutes. The bath should be about half full, to admit of the patient moving and splashing freely without upsetting much water. This bath has a marked stimulating effect on the circulation and respiration. The brief application of the cold water should induce a quick and good reaction, and make the patient feel warm and comfortable. This effect is enhanced if the patient be previously warmed in a hot-air bath or before a fire, and cold water (15° C.) be used. While thermolysis is somewhat avoided by this procedure, thermogenesis is proportionately increased by the stimulus of the cold.

Therapeutic Indications.—Cool and cold plunge baths are of service when general stimulation is desired without lowering of temperature. While primarily stimulating from the bracing effect of the brief exposure to cold water, they are secondarily sedative; not a few people who suffer from insomnia find that sleep is induced by this bath, particularly if they do not dry themselves before returning to bed.

The Full Bath (Cold), or Shallow Bath.—This is now an ordinary household bath, 6 or 7 feet long by 3 feet wide (Fig. 40). The water is cold (8° to 12° C.), and should be kept so by running in fresh water all the time. The duration is very brief—not more than sixty seconds.

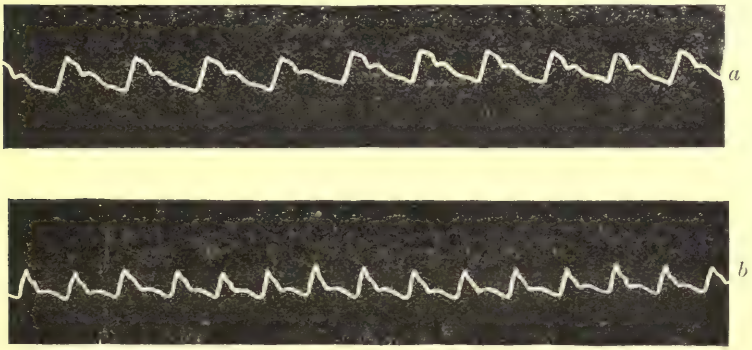


Fig. 41.—Pulse-Tracing: (*a*) Before, (*b*) After a Full Bath.

The patient, having previously cooled his head by wetting it under the tap or with a wet towel, completely submerges the body once or twice, and then gets out. The bath is intensely stimulating and produces a brisk reaction.

The respirations are much quickened, the patient often gasping; the circulation, general and cutaneous, is strongly stimulated (Fig. 41), and the skin markedly reddened.

This bath is frequently used as a sequel to a vapour bath or hot pack, but is only so employed when the patient is robust.

If followed by a half bath at 16° to 20° C., this procedure has a distinct antipyretic action. The cool half bath, by way of comparison, seems tepid to the patient.

Therapeutic Indications.—Where it is desired to strongly stimulate metabolism in cases of gout, syphilis, and obesity, and also in certain cases of tuberculous disease.

For debilitated and exhausted patients it is unsuitable and even harmful.

The Drip Sheet.

The patient having previously been moistened or wrapped in a damp towel, and standing in a warm shallow ($\frac{1}{2}$ inch deep) foot bath, a sheet (2 by 3 yards) folded length-

Fig. 42.—The Drip Sheet.

wise is drawn through cold water and wrapped about him in the following manner: The attendant, approaching from the front, unfolds a portion of the folded border, fixes the free edge of the sheet under the right armpit (Figs. 42, 43, 44), and passes it across the patient's chest, below the left axilla, and around the back and over the right shoulder, so as to completely envelop him.

The patient's entire body is then vigorously chafed and

smacked through the sheet. An active stimulus is provided by the cold, and also by the manipulation. The skin is reddened and the circulation rendered increasingly active; the respirations are quicker and deeper.

The duration of the drip sheet varies. The attendant should keep up the rubbing until the patient feels warm. The effect of this procedure is enhanced, and a good reaction more quickly attained, if the patient has a few minutes' warming in the hot-air cabinet or Turkish bath before the sheet is applied.

FIG. 43.—THE DRIP SHEET: FURTHER STAGE.

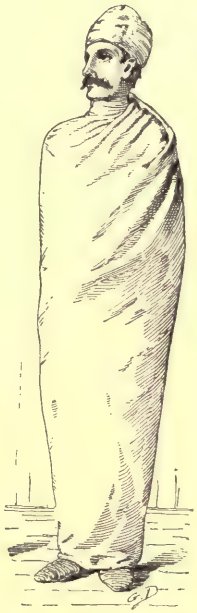


FIG. 44.—PATIENT COMPLETELY ENVELOPED.

The use of the shallow warm foot bath is of particular importance when the patient is weak or sensitive. On a good reaction being established, he is thoroughly dried and allowed to rest for some time on a couch or bed well covered. As a rule a good reaction is sooner obtained if cold water be used, rather than tepid or warm.

Very little antipyretic effect is produced by the drip sheet, but if it is desired to cause heat abstraction, the

sheet should be freely rewetted with cold water and the bath somewhat prolonged.

This application may be varied in several ways. The sheet may be wrung out of cold water before application, and applied merely moist, constituting the "cold rub": given in this way, it is a milder and less stimulating application; or it may be preceded by a hot sheet wrung out of water at 40° C., and applied for half a minute. In the case of delicate and bedridden patients, what is known as the *partial rub* may be employed. A small sheet is used, and each limb dealt with in turn, care being taken to keep the rest of the body warm. This last is an excellent substitute for the half bath in febrile conditions.

General Indications.—The drip sheet is a general stimulant and invigorating procedure, improving the circulation and increasing metabolism. It is of service in catarrhal conditions of the gastro-intestinal tract, feeble circulation, and defective metabolism.

Caution.—It should not be employed in patients who show arterio-sclerosis, in exophthalmic goitre, in the highly nervous, or persons suffering from skin inflammations.

CHAPTER III

DOUCHES, WHIRLPOOL BATH, ETC.

A DOUCHE consists of a single or multiple column of water directed against some portion of the body. The three main factors in this procedure are:

1. Temperature of the water employed, which ranges from 10° to 40° C.

2. The pressure of the water, which ranges from 10 to 60 pounds per square inch, but is usually about 30 pounds. More than this is often unpleasant and may be unsafe. The water is usually projected under pressure, or a mechanical stimulus may similarly be obtained by allowing it to fall from a height on to the patient.

3. A third factor is the volume of the douche, or, in other words, the pressure will vary with the size of the orifice through which the water is projected. The orifice is commonly about $\frac{1}{2}$ inch in diameter, but it may be filiform; or in the descending gravity douche a full $1\frac{1}{2}$ inches in diameter. The pipe of supply should be at least $1\frac{1}{2}$ inches in diameter, and have an independent and separate connection with hot and cold water supplies.

With the douche should be connected a reliable pressure gauge and thermometer. Where it is proposed to use the vapour douche, a steam-pipe with suitable nozzle must be also available.

The best connection apparatus are those of Kellogg and the Fischer Kiefer Co., of Zurich. Whatever appliance is used, it is in the first degree essential that accuracy and precision of dosage, as regards temperature and pressure, are not only possible, but easy to obtain.

The chief varieties of douche are the following:

The horizontal jet.
The percussion douche.
The rain douche, horizontal or vertical.
The fan douche.
The needle bath.
The Scotch douche.
The filiform douche.

Local douches may be applied to the lungs, liver, or spleen (that is to say, the skin surface over them), to the abdomen or perineum.

Modus Operandi.—The douche is one of the most powerfully stimulating procedures in the range of hydrotherapeutics. Its actual effects will depend on the temperature of the water employed, its pressure, duration of the application, form and size of the stream, the region to which it is applied, and the extent of its application.

FIG. 45.—HORIZONTAL DOUCHE.

By the use of the douche the heart is markedly stimulated, with resultant quickened circulation, and the flow of lymph is likewise accelerated, as in general massage. A rapid and powerful reaction is induced. The cold douche is a powerful tonic, and the Scotch douche and alternate hot and cold douche are very powerful excitant applications.

The Horizontal Douche.—This is the most useful and probably most commonly employed form of douche. It

may be in the form of a single jet (Fig. 45), or the jet may be broken and spread out in fan-like fashion (Fig. 52). The usual size of the nozzle is ½ inch in diameter. The force of the jet may be varied by use of the operator's finger at the nozzle.

Care is always necessary not to project the water under too great pressure, especially in the case of nervous subjects.

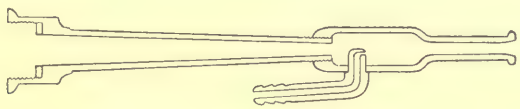


Fig. 46.—Kellogg's Nozzle.

The Percussion Douche.—This is a special form of douche, by means of which a water column of any desired form may be obtained, from a widely scattered shower of large drops to a fusillade of water bullets, which Kellogg likens to the discharge of a Gatling gun (see shape of nozzle in Fig. 46). The pressure under which the water is projected is higher than in the ordinary douche, and a stinging sensation is produced as the water strikes the patient's skin

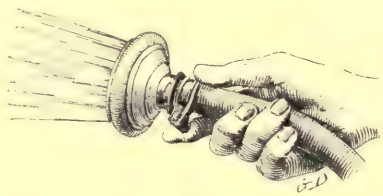


Fig. 47.—The "Rose" for Rain or Spray Douche.

One of the advantages of this application is that the powerful stimulating effect of the percussion allows the use of water of a higher temperature than would be suitable in the ordinary douche, and by many patients who are intolerant of cold water this is much appreciated.

The Scotch Douche.—This consists in the alternate application of the hot and cold horizontal douche. The hot water lasts for from one to four minutes, and the cold is continued for about ten to thirty seconds. The applica-

tion may be general or local, as in the treatment of sciatica. The derivative effect of the application of the hot water is greatly intensified by the subsequent cold water.

The Rain Douche.—This is a common bathroom appliance. The water is projected through a watering "rose," or perforated disc of varying size, falling upon the patient in a number of fine streams.

The pressure of the water is lower in this application, and the reaction follows more slowly than after the horizontal jet.

This bath was much prescribed by Priessnitz, and Kellogg regards it as an indispensable part of a completely equipped hydrotherapeutic establishment.

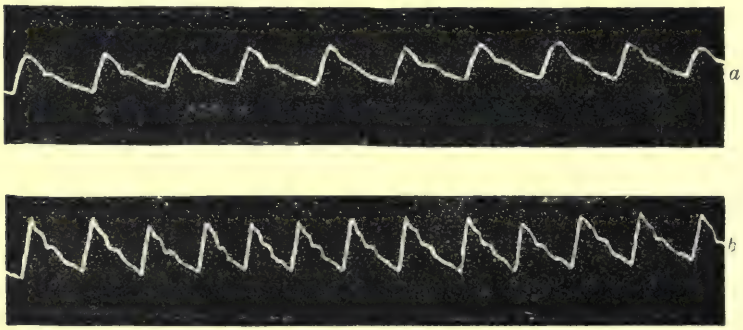


FIG. 48.—PULSE-TRACING: (*a*) BEFORE, (*b*) AFTER A SPRAY DOUCHE.

Combination Needle and Douche Bath.—This consists of a vertical cage, constructed of tiers of circular tubing supported by uprights and pierced with innumerable pinholes, through which the douche is projected upon the patient standing within. The pipes conveying the hot and cold water meet in a mixing box, in which a thermometer enables the operator to regulate the temperature to any desired degree. This bath is commonly combined with the preceding.

The Filiform Douche.—In this the jet of water is horizontal, and issues from an exceedingly small opening, capillary in character. The water is forced under great pressure, and becomes a cloud a short distance from the apparatus. This douche may be applied for any time up

to ten minutes, and is strongly counter-irritant in action. It may, indeed, even induce bleeding.

Therapeutic Indications for Douches..—The cold douche is a tonic procedure of the highest value; it is both alterative and restorative. Under its influence "the individual begins to live a more vigorous life, physically, mentally, and we may say even morally" (Kellogg).

Fig. 49.—The Aix Douche with Two Attendants, as at Aix.

It is of value in most forms of cardiac disease, in rheumatism, and neuralgia. Neurasthenia, chlorosis, and all the curable forms of anæmia, are markedly benefited by it, as also are various dyspeptic conditions and chronic alcoholism.

It should not be used in acute or chronic nephritis, or in badly compensated cardiac disease.

The Scotch douche is of extreme value in various paretic conditions, in sciatica, neuralgia, gastralgia, and lumbago. The cold or alternate douches are also useful in various sexual disorders, such as amenorrhœa, dysmenorrhœa, sexual neurasthenia, and impotence. The combined needle and rain bath is a morning rouser and refresher *par excellence*. The filiform douche is indicated wherever counter-irritation is required, as in sciatica, lumbago, and chronic rheumatism.

The Aix Douche, or Massage Douche, is a most valuable balneological agent, and is extensively used.

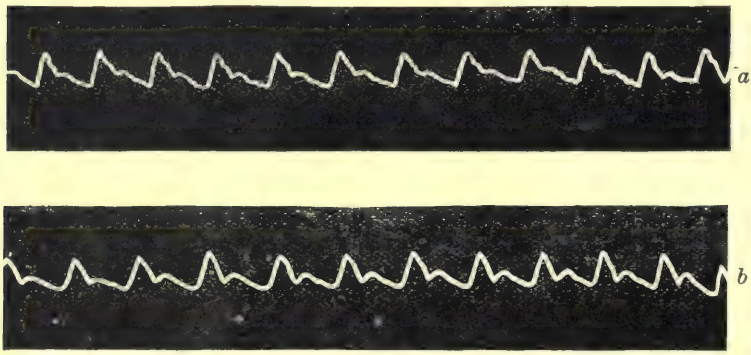


FIG. 50.—PULSE-TRACING: (*a*) BEFORE, (*b*) AFTER A VICHY DOUCHE.

The patient is seated on a wooden stool, or reclines on a board, and a continuous needle spray is directed against the spine, while massage is administered by one or more attendants under a warm douche, conveyed by a flexible tube passing over the shoulder of the masseur (Fig. 49), and playing between his hands. This may be followed by a local hose douche, and the bath terminates with a needle spray, warm at first, and graduated slowly to tepid, cool, or cold, according to the requirements of the particular case. The duration of the bath is twenty minutes. It is useful in a variety of affections, the chief of which are chronic gout and the gouty state; chronic rheumatic arthritis, lumbago, and sciatica; arthritis deformans; in toxæmia from high living with sedentary

habits; in cases of brain fag from too assiduous work; in obesity; in heart disease of peripheral origin; and in many other disorders.

The Vichy Massage Douche resembles the Aix douche very closely, with some modification of procedure. The patient lies in a recumbent position on an india-rubber air mattress, while massage is administered under a spray douche projected from a series of brackets pierced with pin-holes suspended over the table (Fig. 51). The duration

Fig. 51.—The Vichy Douche with Three Sprays.

of the bath is twenty minutes, and it terminates with a needle spray. A preliminary steam bath is often given, and free perspiration induced before the massage is started.

The Aix Douche.—This is a modification of the Vichy douche, in that the patient is usually sitting. The apparatus used at Aix is described by Forestier as follows:

1. The jumelle, which consists of a couple of pipes, one for hot water and one for cold, entering into a small reservoir or *mélangeur*, in which they are mixed. From this reser-

voir, which is provided with a thermometer, starts an india-rubber hose with a bent nozzle held by the masseur in front of the patient.

2. A metal box (*boîte de mélange*), which is fixed about 6 feet from the ground to receive the mixture of hot and

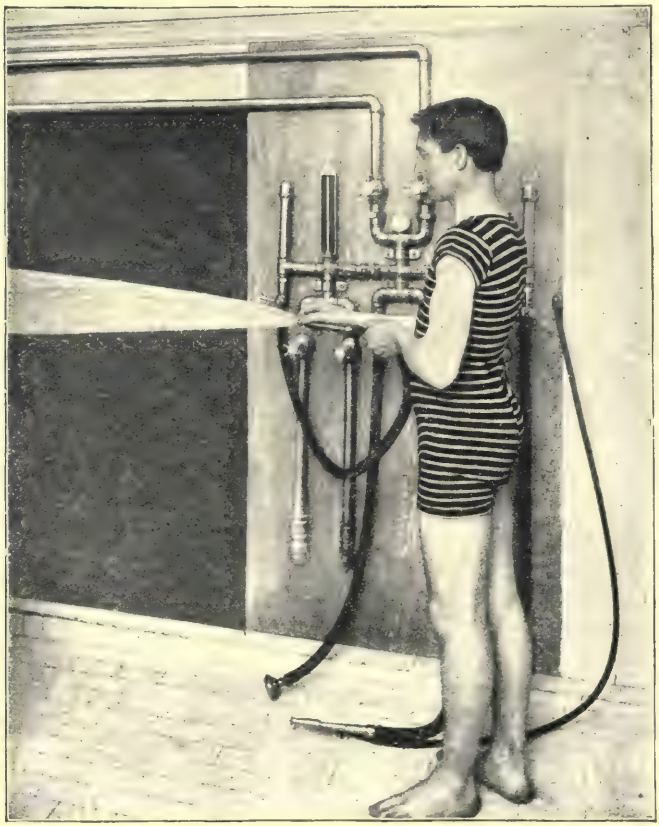


FIG. 52.—THE BROKEN HORIZONTAL JET DOUCHE.

cold water, and connected with an india-rubber hose fitted with a rose, which is held by the masseur standing behind the patient. The first apparatus carries the water coming from the upper reservoir at a high pressure (45 feet above the ground floor, 20 feet at the second floor). But this pressure has little importance, the object being to have

a not too strong stream of water, which by its splashing would only inconvenience the masseurs at their work.

The last article to mention is the specially constructed low chair or stool with side arms and no back on which the patient sits. By laying a wooden board on it this stool can at will be turned into an inclined plane, on which the patient lies face downwards.

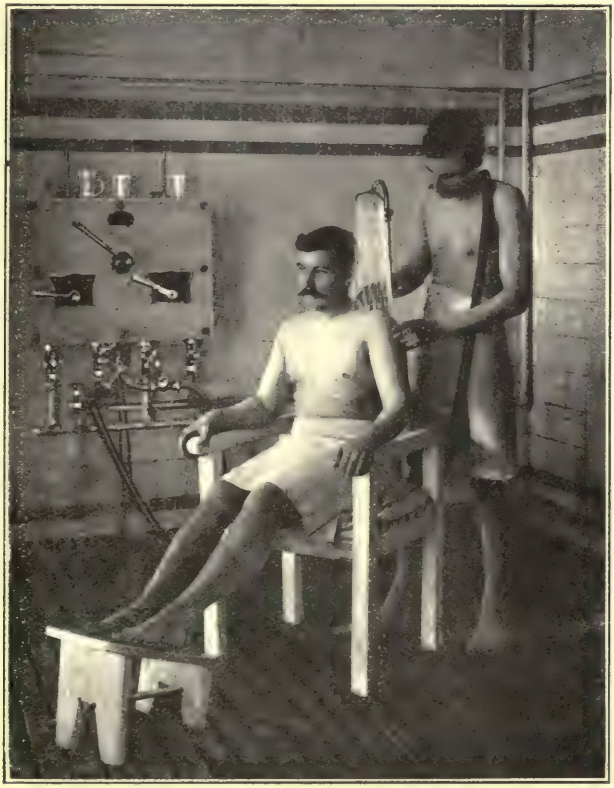


Fig. 53.—The Aix Douche.

Administration of the Douche.—The first part of the douche massage is performed after the old Aix system in the sitting posture. The patient sits on the stool above described, and the two masseurs or masseuses massage the limbs or upper part of the trunk; as they rub they keep

the jet of warm water pouring on the part of the body being treated at the moment. The hose is largely manipulated by the masseurs' knees or thigh, which they can do very cleverly. Thus the arms remain at liberty. The masseur standing behind does the massage of the neck, shoulders, and upper part of the trunk; the other, standing in front of the patient, carries out the massage of the upper and lower limbs.

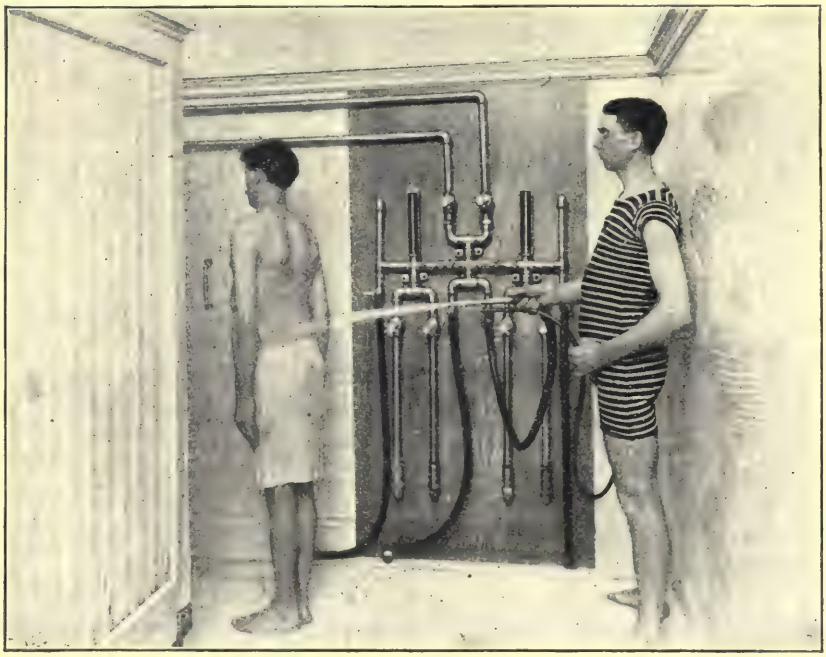


FIG. 54.—THE HORIZONTAL PERCUSSION DOUCHE.

As regards the second part of the douche massage, the patient is kept in the reclining posture, as first suggested by Forestier and adopted at Bath. The wooden board is laid on or against the stool, and the patient lies on his stomach. This enables the masseur to handle to the best advantage the back of the limb (sciatic nerve), along with the hips and lumbar region.

Finally, the patient stands up, and while one masseur is

preparing the towels, the other gives him a simple douche down. The patient is well dried off and wrapped in a flannel dressing-gown and blanket, placed in the sedan chair used, and carried back to the bedroom.

Owing to the great skill and care shown at Aix, where this douche has been used so long, it is given with perhaps less fatigue, if not better results, than anywhere. The nearest imitation in this country is probably Bath.

The Scotch Douche. — This was first devised by the eighteenth-century Edinburgh physician Cullen. It was prescribed as a tonic chiefly, and consists in a warm stream of water for one or two minutes, and then a sudden cold stream for a few seconds. It was first called the Scotch douche by Dr. Despine of Aix, whose grandfather was appointed Director of the Aix Baths in 1787; he had studied under Cullen at Edinburgh, learning there the value of the cold douche. He therefore named it the *douche écossais*. It is valuable in the later stage of sciatica, or, indeed, any considerable neuritis.

The Whirlpool Bath.

The principle underlying this treatment is the application of what is known in France, where the bath was first used, as *eau courante* or *anglice*, "rushing" water, rather than running water, for the treatment of stiff joints, contractures, and war injuries of various sorts.

The baths first employed in this country were copied from the French model, in which hot and cold water supplies are led into a mixing chamber, whence the water at required temperature passes into the bath through a number of jets.

After rushing around the bath, the water flows through an opening near the top. The whirlpool effect is thus produced by a constantly flowing stream of rapidly flowing water. To obtain a satisfactory stream a pressure of at least 50 feet is needed, and the water consumption is heavy. To obviate this disadvantage a bath was introduced in which the whirlpool was produced by means of an electrically driven turbine placed under a grating in the bottom of the bath. A small quantity of water only is admitted

Fig. 55.—The Whirlpool Bath.

from time to time in order to maintain the temperature, while a corresponding amount is allowed to flow through the waste pipe. A very small quantity of water is thus required only. A further modification has been added whereby the water can be made gaseous, which enhances the effect and has been specially useful in neuritis.

Baths are made of various types and sizes—some for arm or legs, and a very large one in which not only one but several patients can sit and be treated at the same time. The period of immersion is usually about twenty

Fig. 56.—The Whirlpool Bath.

minutes. Temperature from 110° F. to 120° F., or as hot as can be borne comfortably. Before immersion of the limb the water is kept at 100° F., and then gradually raised to the limit of endurance. Several treatments may be necessary before so high a temperature as 120° F. can be borne. This is particularly the case where there are areas of anæsthesia and defective sense of heat and cold, as severe scalding might occur without the patient or physician at first being aware. Shortly after immersion the skin becomes flushed and red, pain is relieved, and a comfortable sensation induced.

The tissues become more supple, and movements can be made which were previously painful or impossible. After the bath the limb is found to be in a condition of hyperæmia, with the skin red and hot—in all probability with the internal temperature raised, as after diathermy or electro-penetration.

There is usually an increase in bulk varying from $\frac{1}{3}$ to $\frac{1}{2}$ inch in circumference. The tissues are soft and relaxed, and will bear massage and manipulations which before the bath would have been painful.

Thus the procedure is very commonly used as a preliminary to massage treatment. It is claimed in traumatic affection at any rate that in this respect the whirlpool bath is an improvement on radiant heat; that is to say, the skin is less irritated and the deeper tissues more thoroughly penetrated.

Adhesions can be more readily broken down. A further point with this bath is that it is not only a bath, but a delicate form of massage in itself, so that cases unfit for manual manipulation can be treated by it without pain or damage of any sort to the tissues.

It has been used with great success in cases where the nerves in the vicinity of a wound have been slightly damaged but not destroyed, and where ordinary heat and manual massage are too painful. Also in the referred pain after an amputation great relief has been given.

A complete outfit is expensive, but a bath for arm or leg does not cost a large sum. Messrs. Shanks of Barrhead have taken a great interest in the subject, and fitted up a large number of these baths all over the country.

CHAPTER IV

THE TECHNIQUE OF COMPRESSES, PACKS, POULTICES, ETC.

The Wet Compress.

THE wet compress (or *Umschlag* of Priessnitz) consists of a swansdown or linen fabric wrung out of water of varying temperature and applied to the surface of some part of the body. The compress is usually applied with a covering of some dry and, for choice, rather impermeable material to prevent loss of heat by evaporation. Unless so covered, a warm compress will rapidly become cold and any compress dry. Flannel does best as a covering, rubber fabrics being too impermeable, and as a rule preventing evaporation too completely.

The action of a cold compress is somewhat obscure. It has been explained from the point of view of the osmotic pressure of the tissues and tissue fluids. The osmotic pressure of a solution may be said to be *the pressure which dissolved substances exert on the molecular surface of the fluid in the endeavour to increase the latter.* This pressure may be very considerable. In health, the osmotic pressure of human blood-serum is constant, and is about $7\frac{1}{2}$ atmospheres.

Variations of osmotic pressure may be expressed in another way by stating the lowering of the freezing-point of the solution under examination. Blood-serum has a freezing-point depression of 0·56° to 0·57° C. (briefly expressed as Δ). The endeavour on the part of the body to keep this pressure at a constant level is spoken of as the "isotonic balance" of the blood and tissues.

In inflammatory conditions the osmotic pressure is changed and the isotonic balance lost. In order to under-

stand the conditions affecting an inflamed area, we may analyze such a simple condition as a boil. In this the central pustule is at abnormally high osmotic pressure, ranging between 0·6° C. and 0·8° C., and may even rise to 1·4° C. Passing outwards, one comes to the hyperæmic zone, in which the pressure is still too high, but is increasingly lower the farther we go from the central pustule. Outside this is the area of manifest œdema, which has a pressure varying from about 0·75° C. close to the hyperæmic zone to 0·56° C., which is the pressure of normal tissues. The importance of this change in pressure is realized when one learns that the volume of a cell diminishes as the osmotic pressure of the fluid in which the cell is suspended is raised above that of the cell itself. Thus a red blood-corpuscle loses about one-quarter of its volume when suspended in a 1·5 per cent. solution of sodium chloride (Δ equals $-0·9°$ C.) compared with a cell suspended in 0·9 per cent. solution of sodium chloride (Δ equals $-0·56°$ C.). Next, as is well known, the structure of a cell is materially altered by suspension in a fluid of higher osmotic pressure than the cell itself. Red cells lose their disc shape and become spherical when kept in 1·5 per cent. solution of sodium chloride. Correspondingly, the function of a cell suffers when the isotonic balance is lost. This can be measured by watching the phagocytic power of leucocytes suspended in a saline solution of varying strengths. Clinically it is found that when the osmotic pressure of a part is raised, the part has undergone an injury, and an inflammatory reaction results.

Isotonic solutions may be injected into the tissues without any disturbance of a pathological nature, but pain invariably results if the solutions be hyper-isotonic. This statement does not apply, of course, to substances which are escharotic, or possess corrosive action on the tissues with which they are brought into contact.

The osmotic pressure of the tissue fluids thus plays an important part in the process of inflammation. The Priessnitz application causes a reactive hyperæmia, and thus tends to re-establish the balance of osmotic pressure. Schade considers that while the compress possesses no

special action on the area of hyperæmia—*i.e.*, the pustule and its immediate vicinity—it yet converts the local anæmia of the œdematous zone into a local hyperæmia. The result of the increased circulation through this zone is to heighten the lymph circulation centrifugally, thus getting rid of the products of inflammation rapidly or rendering them harmless by neutralization with the various substances in the lymph or serum.

Hot compresses just covering the acutely inflamed area rather increase the pain, while those reaching over the whole of the area affected allay pain rapidly; further, *ring-shaped* fomentations just covering the area surrounding the central inflammatory area also rapidly allay pain.

The duration of a compress will depend on the effect desired. Generally speaking, cold compresses are renewed as soon as they become warm, and hot compresses as soon as they become cool. If cold compresses be left on until they become warm, they act as poultices and stimulate inflammatory changes. Compresses dry more rapidly on patients with brisk circulations and hot dry skins than in those with feeble circulation and who are in an asthenic or cachectic condition. A maximum stimulating effect may be obtained when hot and cold compresses are applied alternately to any part of the body; the circulation in the part is increased and the local metabolism markedly stimulated.

Therapeutic Indications..—Cooling compresses are useful in all local pathological conditions of an inflammatory nature, and aid in the removal of hyperæmia or congestion and in the relief of pain.

Warm compresses promote suppuration and increase local tissue changes and the absorption of morbid products. They have a local antispasmodic action, and often relieve the pain of neuralgia, rheumatic joint pains, etc.

The Various Compresses in Use.

The Head Compress.—This is a well-known application, and one of great service in various congestive conditions of the brain and meninges. The compress is applied either

to the top or the back of the head, and in the latter case the back of the neck is included in the application. If necessary, the whole face and scalp may be treated together. It must be borne in mind that a cold application to the forehead will cause collateral hyperæmia of the brain, while one over the jugular region will tend to cerebral anæmia. A brief hot compress will act in the same way. Headaches of a neuralgic character are often relieved by this compress. In febrile and congestive headaches cold compresses afford most relief. The head should be carefully dried after the compress has been removed (Fig. 57).

FIG. 57.—HEAD COMPRESS.

Throat Compresses.—These are very commonly employed domestically, but are very seldom correctly applied, for the usual method is to fold a handkerchief into a narrow bandage and then wind it round the neck like a collar or muffler. So applied, it rapidly becomes useless, for it is soon displaced from its original position by the patient's movements, and air is allowed to enter. The proper mode of application varies with the condition to be dealt with (Fig. 58). In any tracheal or laryngeal trouble, one end of the bandage should be wetted and covered with the other, which is dry, to delay evaporation; or a wetted linen handkerchief should be applied and covered with another, preferably of silk, and larger in size than the under one.

In affections of the tonsil and pharynx the application should be made as follows:

A piece of swansdown calico, long enough to reach from ear to ear passing underneath the chin, is folded into a

FIG. 58.—THROAT COMPRESS.

four-layer compress. A bandage of flannel 8 inches by 24 inches, provided with a slit for either ear, is also made; these are fitted by actual measurement to each patient. The calico compress is now wrung out of water at 15° C., and

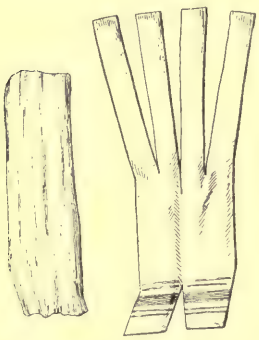


FIG. 59.—THE KELLOGG COMPRESS.

FIG. 60.—COMPRESS FOR TONSILS AND PHARYNX.

laid on the flannel bandage which is to act as a cover. The wet compress being placed under the chin, the flannel bandage is now unrolled from the top of the head, on the right, the ear being allowed to come through the slit, and

then carried underneath the chin and up the left side (Fig. 60). The whole compress is secured by means of safety-pins, care being taken that while it is sufficiently tight it is not uncomfortably so. A hot compress applied for twenty minutes, and then followed by a cool one, will do good in many throat inflammations. If suppuration has started, as, for instance, in Ludwig's angina, the hot compress will encourage the suppuration and tend to bring

FIG. 61.—CHEST COMPRESS.

it to the surface. In early inflammatory conditions a cold compress will often go far to subdue and check the inflammation.

The Chest Compress.—A pad of towelling or swansdown calico, eight folds thick, is wrung out of cold water (iced if desired) and applied to the chest for twenty minutes. This is covered by a flannel cross-binder, which passes over the patient's shoulders and is finally fixed by a tape (Fig. 61).

After the application is completed, the patient is carefully dried and rubbed with a rough towel. In pleurisy of a dry and painful character, this compress is often very soothing to the patient; it is also helpful in pericarditis and cardiac excitement. In all cases of hæmoptysis it is a valued and serviceable application. Care must be taken, however, not to employ it in cases where there is presumably marked fatty change in the myocardium associated with cyanosis, pulse irregularity, and restlessness on the part of the patient (Kellogg).

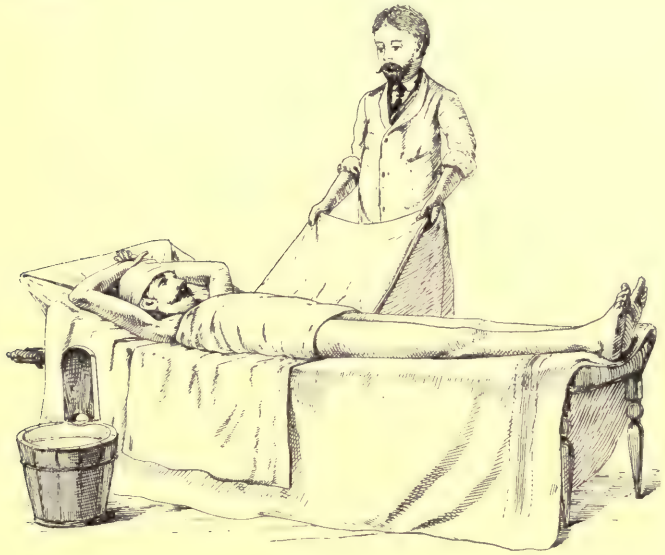


FIG. 62.—COMPRESS FOR TRUNK.

Cooling Trunk Compress.— A small blanket, no broader than will reach from armpit to hip, is spread across the bed, with a waterproof sheet of like size beneath. Upon these is laid a cotton sheet wrung out of cold water, six to eight folds thick, of nearly the same breadth, long enough to embrace the trunk with the arms excluded, and well overlapped in front. On this the patient lies down (Fig. 62), and the sheet is brought round and tucked tightly underneath the flanks, each side in turn, the blanket in like manner, and the waterproof over all. A hot-water bottle

to the feet and a cold cloth to the head are then applied, and the patient's lower extremities warmly covered up.

This application exercises a markedly antipyretic effect, especially if frequently renewed. In febrile conditions in which drugs seem to have very little effect on the pyrexia, this application will frequently bring the temperature down several degrees in a few hours.

Most patients say they find the compress very comforting, and, indeed, it is a most convenient and valuable therapeutic agent. In the feverishness of children due to some gastric disturbance it is especially valuable, and the writer has found it of service in acute pneumonia.

Although the antipyretic action is enhanced by frequent renewal, in many cases it may be left on for four or five hours, or even all night, without changing. Hyperæmia is induced on the surface of the abdomen, and sleep is encouraged by the resultant cerebral anæmia.

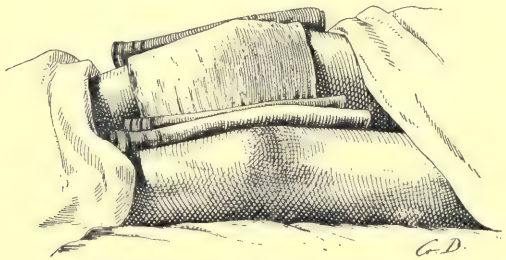


FIG. 63.—JOINT COMPRESS.

The Abdominal Bandage (or Neptune's Girdle).—This is a piece of swansdown calico, 3 feet long by 8 inches to 10 inches wide. A length sufficient to go one and a half times round the patient's abdomen is immersed in water, wrung out, and wrapped round the part. The dry portion is then folded over the wet, so as to prevent undue evaporation, and may be further covered by a waterproof cloth of some sort, the whole application being secured by means of tapes.

This bandage can be worn quite well whilst the patient, if a man, goes about his ordinary daily occupation, but is inconvenient for women owing to the corset. It is an application of some value in various digestive disorders,

and is generally of a soothing nature, though nervous, irritable subjects often dislike it, and are kept awake at night by it.

Circular Joint Compresses.—These are made of strips of swansdown, 18 inches by 6 inches, wrung out of water and applied to the joint to be treated, covered with flannel or waterproof. They are useful in various rheumatic joint affections (Fig. 63).

FIG. 64.—ELECTRO-THERMAL COMPRESS.

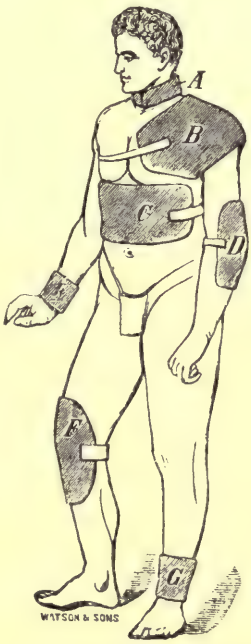


FIG. 65.—THE COMPRESSES APPLIED.

The Electrothermal Compress (or Electric Thermophore).—This was invented by Cerruti, and has for a number of years been in use in Italy, especially in the hospitals at Turin. The apparatus is really a compress consisting of light, flexible, and incombustible pads, containing electrical heating apparatus in the form of threads of asbestos, around which are wound fine coils of resistance wire (Fig. 64).

These threads are arranged in spirals between the folds of the compress, are perfectly insulated, and are attached at one end of the pad to thicker wires which can be connected with the ordinary electric supply, so that when the current is turned on the compress is heated uniformly throughout. The amount of current passing is regulated by means of a small rheostat, and any desired temperature up to about 150° C. can be arranged for. There is a removable outside cover for each compress, which can be periodically cleaned.

These compresses are extremely convenient and inexpensive, but, of course, can only be used in houses where the electric current is laid on. Placed in contact with the skin, they are an excellent medium for the application of dry heat; while by inserting a piece of damp cloth between the compress and the skin, a poultice is formed which can be maintained at any desired temperature for an indefinite length of time.

The Wet Pack.

This is applied in the following manner: A blanket 2½ yards square is placed on a suitable couch or stretcher bed, and upon this is laid a coarse linen sheet wrung out of water at 16° to 18° C.

The patient, around whose head a cool compress has been arranged, now lies down on the sheet, which is carefully and smoothly wrapped about him in the following manner: His arms are raised above his head, and one half of the sheet is drawn across his body, its upper portion tucked alongside the trunk and the lower between the lower limbs. The arms are brought down to the side of the body (Fig. 66), the other half of the sheet being arranged so as to include them, and its border tucked in along the opposite side beneath the arms and between the legs in such a manner that the two skin surfaces do not come into contact. The blanket is then brought together at all points, particular care being taken to cover in the neck and shoulders (Fig. 67).

The blanket is usually equal to one and a half times the circumference of the patient's trunk, and serves to keep in the heat. It is necessary to wrap it pretty firmly round the patient and to restrict movements of the limbs; at the same

time we must avoid rendering him uncomfortable or giving him pain. The feet should be kept warm by means of a hot-water bottle or the previous application of friction.

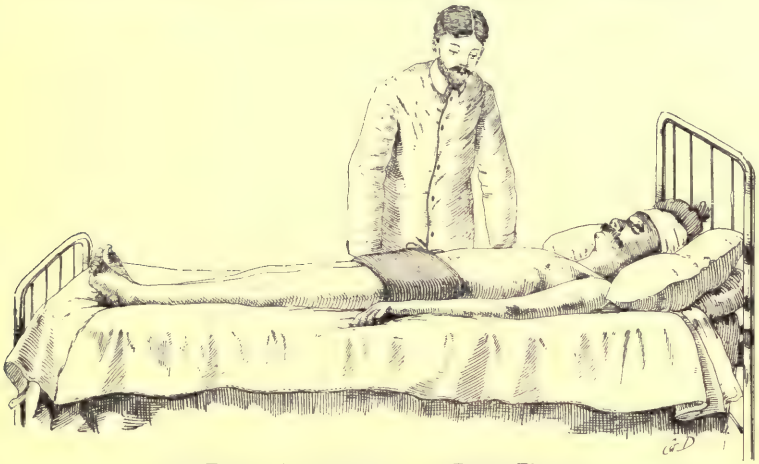


FIG. 66.—APPLICATION OF WET PACK.

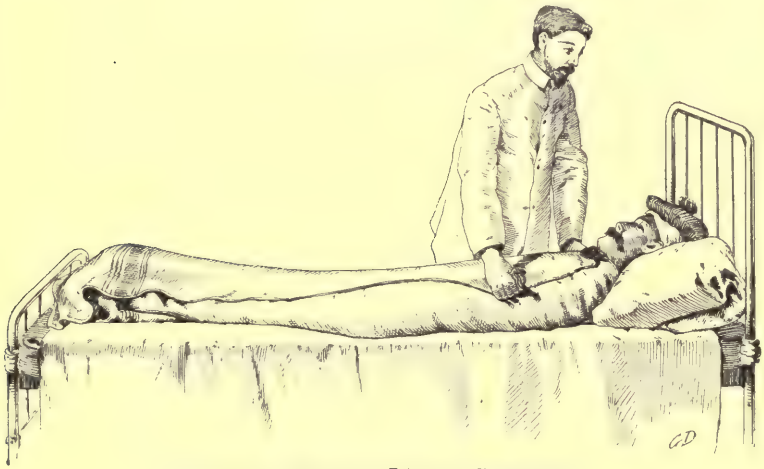


FIG. 67.—THE WET PACK COMPLETE.

Action.—The whole body surface is at first markedly stimulated by the cold sheet, and quickened heart action and respiration result. Usually the sense of cold disappears in about a quarter of an hour, and the patient becomes

warm and comfortable. The peripheral vessels dilate, the pulse slows, and the patient feels drowsy, often falling asleep. Later perspiration may take place, depending on the duration of the pack, which will vary according to the effect we desire to produce. If the pack be changed frequently a marked antipyretic effect is obtained. The warm reaction is slower each time the pack is repeated.

The Dry Pack.

This application is similar to the wet pack, only the wet sheet is omitted and a soft, thin blanket or flannel sheet is used in its place, covered on the outside with a thick blanket. Indeed, very often merely a single thick blanket is employed. The patient is very completely enveloped, and a hot-water bottle placed at the feet (Fig. 68).

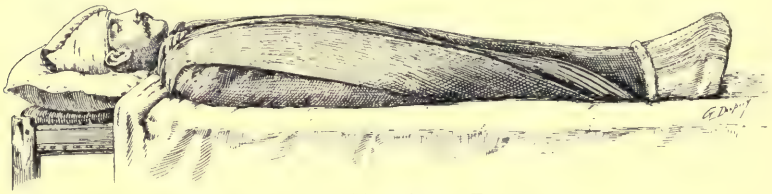


Fig. 68.—The Dry Pack.

Reddening of the skin is rapidly induced by the irritation of the blanket, and the body soon becomes warm. Perspiration appears with a rapidity which varies with the individual—on an average in one and a half hours, and sooner than in the wet pack. The body temperature rises, the tongue becomes dry, the pulse and respiration quicken, while the head feels somewhat full and congested. Considerable discomfort is experienced by the patient until perspiration is actually established. The onset of perspiration may be hastened if certain preliminary measures be taken. One method is to place the patient in a hot full bath (40° C.) for ten minutes before applying the pack. This is useful when the patient is suffering from chronic granular kidneys associated with high blood-pressure. Another method is to get the patient to put on very warm clothing and engage himself in active muscular exertion,

such as swinging Indian clubs, for ten minutes or so, and then put him in the pack. The pack may also be made more active and efficient if the patient lies on an electric sweating mattress (Fig. 69), in which heat is generated by the resistance of thin conducting wires.

While perspiration is going on, cold water should be freely drunk, and on the conclusion of the pack the patient should be well lathered down and given a cold spray douche.

Needless to say, such a method of inducing diaphoresis is much more clumsy and tedious than the hot-air or electric-light bath; but blankets are often available where these latter luxuries are not to be had.

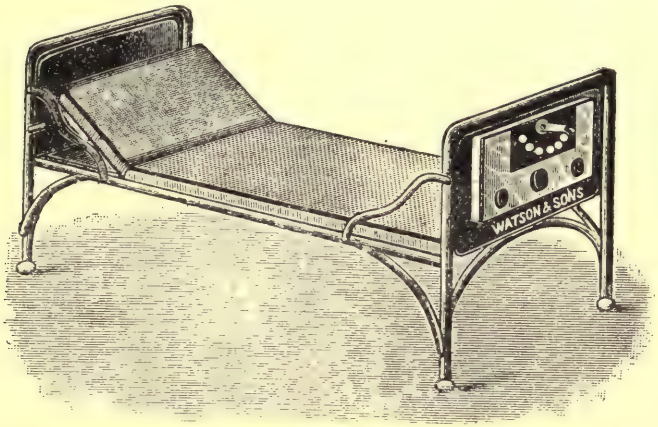


FIG. 69.—ELECTRIC SWEATING MATTRESS.

THERAPEUTIC INDICATIONS.—Metabolism is generally stimulated by these packs, but if often repeated they are very depressing and enervating, and are contra-indicated if the patient has a weak heart. They are indicated in any acute or chronic toxæmia in which the establishment of diaphoresis is desirable.

In febrile conditions, the antipyretic effect of the wet pack may be of great service. Too prolonged application or too often repeated packs will cause some cardiac depression, and care is therefore needed in this respect. Provided there be no marked cardiac asthenia, however, in some cases of hyperpyrexia as many as a dozen packs may be

given. In diphtheria this pack is of especial use, combined, of course, with the usual antitoxin treatment.

Other conditions benefited in a varying degree are: Neuralgia, chorea, exophthalmic goitre, muscular and articular rheumatism, and rheumatoid arthritis.

For patients who are unusually nervous in disposition, and resent the complete wrapping up and restriction of movement, partial packs may be employed, which, while less powerful, are efficient for soothing and hypnotic purposes.

Fomentations and Poultices.

Fomentations and poultices are simply local baths to the skin. If there be an inflammatory condition of skin or structures covered by it, these applications are a convenient and efficacious means of employing warmth and moisture in the treatment, relieving the vessels, increasing the collateral circulation, and so relieving the local circulation and pain. Thus applied at the commencement of inflammation, they often summarily check it, abort threatening abscesses, and prevent the formation of pus. Acne indurata and herpes labialis may be much restricted by the application of fomentations. Discrimination in their employment is needful, for conditions such as impetigo contagiosa are fostered and made worse by such applications.

Again, if an abscess has actually formed, the repeated application of hot fomentations serves to "bring it to a head," as the vulgar phrase goes, helps the expulsion of the pus without the aid of the surgeon's knife (though this may be often a shorter and more æsthetic cure), and prevents the diffusion of the inflammation.

To be efficacious, a poultice or fomentation *must* be hot —indeed, as hot as can be borne—and must be frequently changed, at least every two hours.

If the object of the poultice be to hasten an abscess bursting, it should be large and ample; but when the abscess has burst, a small poultice or fomentation about the size of the aperture should be used, or the surrounding skin will become sodden and irritated from the repeated application.

Apart from the soothing local effect of fomentations on inflamed tissues, they have a similar action on deep-seated and more or less remote parts (*vide supra*). Thus large hot poultices are of great service in pleurisy, pneumonia, bronchitis, pericarditis, and peritonitis. In dealing with pneumonia, caution is necessary not to cause additional respiratory embarrassment by using poultices, especially for children. A jacket of cotton-wool or gamgee sprinkled with turpentine or camphor liniment may be preferable in such cases. The jacket poultice for children has fallen somewhat into desuetude.

In peritonitis, too, a poultice should not be thick and heavy, or the pain may be made worse. Poultices are useful in acute rheumatism, sciatica, pleurodynia, and in various rheumatic pains and acute lumbago. In this last condition the poultice should be large, thick, and very hot; it should be changed about every thirty minutes, and may be kept up for three hours if necessary.

In changing poultices, the fresh one should be ready in hand while the cooling one is removed, so as to avoid chilling the skin.

Fomentations are usually composed of several thicknesses of flannel wrung out of boiling water. They are less weighty than poultices, and less messy and septic. The water is wrung out of the flannel by means of a wringer made of stout huckaback towelling attached to two sticks (portions of a broom-handle do well). The flannel, after immersion in boiling water, is placed in the wringer, which is then firmly twisted round the flannel until the water is squeezed out. The operator who manipulates the sticks thus avoids scalding his hands, though the water may be very hot. The heating may also be conveniently done by steam, and this is, of course, always available in a properly equipped bathing establishment. Having been exposed to the steam, the fomentation is run through a roller to remove any excess of moisture. Until actually applied to the patient, the fomentation is kept tightly rolled up in a towel, by grasping the loose ends of which a final squeeze can be given to extract moisture. The proper temperature of the application is gauged by the back of the attendant's hand.

These pads are made in two sizes, one 11 inches by 22 inches, and a larger 22 inches square. They are about ½ inch thick and quilted. When applied they only contain water which is actually absorbed by the material; they should be covered at once by some mackintosh material, and frequently changed, as they cool rapidly. When finally removed, the skin of the patient should be wiped dry and covered with a layer of flannel or cotton-wool to prevent a chill being taken.

Such hot fomentations are most useful in various colics—renal, biliary, or gastro-intestinal.

A hot pad may be alternated with a cold pad in certain conditions, as follows: The hot pad is applied for five minutes, and then a piece of soft calico towelling wrung out of cold water is laid over the part, being kept on for five minutes or more, when the hot pad is once more applied to the surface. Such applications are useful in gastric and gastro-intestinal catarrh.

Fomentations may also be medicated in various ways, the most common being the application of 20 to 30 drops of turpentine oil, constituting "the turpentine stupe."

Poultices are made of various substances—bread, linseed meal, oatmeal, or starch. Each has its peculiar advantages. The linseed and oatmeal poultices possess very similar properties. They are very compact, slightly porous, and retain their heat and moisture well. Linseed is somewhat irritating to certain skins. Bread poultices are more porous, cool more quickly, and dry more easily. Starch poultices are very soothing, and retain heat for a considerable time.

For making poultices the water should be boiling, and all the materials ready to hand. A sufficient amount of boiling water should be poured into a heated bowl, and the linseed meal, etc., sprinkled in, the mixture being quickly stirred until the mass is of a doughy consistence. This is then rapidly spread on warm linen, the edges of which are so turned in as to prevent any of the poultice escaping. Quickness is essential if the poultice is to be hot. If the water be added to the *meal*, a lumpy, uncomfortable mass will result, not an evenly consistent, soothing poultice.

Bread Poultices may be made by cutting up stale bread

into thick slices, pouring boiling water over them, and soaking for a few minutes; or the mixture may be simmered in a saucepan for a short time. The bread is then strained and beaten up into a paste, and spread. The poultice is more porous if the first method is adopted.

Starch Poultices.—A little *cold* water is added to any form of starch, and a pulp made; sufficient boiling water is then added and the poultice spread.

Bran Poultices are often convenient on account of their lightness. The bran is placed in a flannel bag, and boiling water poured on it.

Mustard Applications.—In making up the mustard pads, a large tablespoonful of mustard is allowed for each pint of boiling water, or a breakfast-cupful of mustard bran to the same amount. The cloth is wrung out of this after a minute has been occupied in stirring up the mixture and another minute for settling. For less sensitive skins, a paste is made of mustard (and for this the mustard bran is quite strong enough) and spread on the face of a hot cloth with a thin fold of muslin laid over it, and this is so expeditiously applied as to insure a hot application. Table mustard and linseed or oatmeal in equal proportions are equivalent in strength to a like bulk of mustard bran.

Mustard Cloth.—A piece of calico or towelling, fourfold, wrung lightly out of hot mustard and water, is applied as hot as it can be borne to the part indicated, and kept in close contact for twenty minutes at the most. If felt too acutely, it may be removed earlier. The effect of the above may be accentuated if it is preceded by a hot fomentation for five minutes. This is what is commonly done for—

The Liver Pack.—A small blanket is laid across the couch or bed, with waterproof material beneath. The patient lies down on this, and a hot fomentation, large enough to cover the whole hypochondrium, is applied for five minutes, and then replaced by a mustard cloth. The mustard cloth is usually retained for fifteen minutes. When patients are intolerant of mustard, the hot pad alone is used.

Mustard Plaster.—The following is recommended by Whitla as a rapid and convenient method of preparing an ordinary mustard plaster:

The required quantity of mustard is put into a large cup (about a tablespoonful of mustard makes a large sinapism), and as much cold water is poured on as will produce a soft uniform cream, not quite so fluid as to pour out readily. A sheet of paper is procured of such thickness as will readily permit the fluid part of the cream to soak through without becoming too easily torn. Old newspaper is the best for this purpose, and it should be laid upon a table or smooth surface, the mustard cream turned out of the cup, and roughly smeared or spread over its centre. The circumferential or clean parts of the paper are folded over this, making the required shape and size of the sinapism, which is lifted off the table and the surface which was undermost applied to the patient's skin.

When the materials are at hand, less than a minute is enough to perform this little operation. The plaster can be best carried to the bedside on a plate. The mustard itself does not actually come into contact with the patient's skin, but only the fluid which soaks through the paper between the skin and the cream.

The sinapism should be kept in contact with the skin by means of a bandage or pad of flannel. It is difficult to lay down any absolute time during which the plaster should remain on, for it will vary very much in individual cases. After being applied for a few minutes, however, the edge of the plaster should be raised and the skin inspected. If it remains scarlet for a few minutes, the application should be removed, but if the redness disappears, the application should be continued. The twenty minutes above specified in regard to mustard cloth are only approximate, and represent the maximum. To push endurance to the point of distress is a mistake, converting what should be a benefit into an injury. The patient must be told that when the limit of reasonable endurance has been reached, he must do like Tom Sawyer, and "holler 'Nuff!'" It must be further borne in mind that mustard applications are hurtful in the extreme when the skin over the part concerned is inflamed, or, indeed, shows any form of irritation. In such circumstances a plain hot pad without mustard must suffice.

The Ice-Bag.—Of this there are various forms. That we are most familiar with is the small ice-bag which we see in the wards of any hospital (Fig. 70). It is a small bag of rubber provided with a metal cap and filled with broken ice. The ice-helmet is a modification of this; and there is also the well-known Chapman's spinal ice-bag (Fig. 71). Various

FIG. 70.—ICE-BAG.

appliances are now made of Leiter's tubing, whereby ice-cold water may be allowed to flow in immediate proximity to any inflamed region, and the cooling effect of such an appliance is considerably greater than an ice-bag.

Such appliances are of great use in spinal injuries, and congestions, acute myelitis, and spinal or cerebral meningitis. Opinions differ somewhat as to the value of an ice bag in pleurisy. Affleck considers it a most valuable method

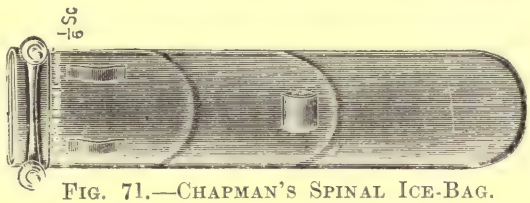


FIG. 71.—CHAPMAN'S SPINAL ICE-BAG.

of treatment and very soothing to the patient, while Kellogg considers it is contra-indicated. The latter, however, speaks highly of the ice-collar in diphtheria, when applied for fifteen or twenty minutes in place of a fomentation. The effect is to decrease the hyperæmia of the affected area reflexly, and also by contraction of the carotids.

Chapman made a variety of claims for his spinal ice-bag which have been more or less substantiated. He found it had a sedative influence on the spinal cord, but also that he could to some extent increase or diminish the circulation in any part of the trunk by varying the part of the spine to which he applied the bag. If he wished to influence the head, he applied the bag to the neck and shoulders; if the chest and arms, he applied it to the upper part of the back; and to the lumbar region for the pelvis and legs. In this way he could influence the occurrence of menstruation, and he states that after a brief application to the lower dorsal region he has seen the feet become very rapidly warm. He also found it useful in sea-sickness and the vomiting of pregnancy. By filling the bag with hot water, on the other hand, he could induce contraction in the vessels which were dilated by the application of cold, and was in this manner able to arrest menorrhagia, epistaxis, and other hæmorrhages.

CHAPTER V

NAUHEIM BATHS

THESE baths have been known for about half a century, and many physicians of repute have advised their employment in the treatment of various forms of cardiac disability. The water used in the baths is charged in varying degree with carbonic acid gas, and containing small quantities of saline matter, such as chloride and sulphate of soda.

The specific gravity varies, but averages about 1005. At Nauheim the springs used for this purpose contain chloride of sodium, chloride of calcium, and a varying amount of CO_2. The "Neuer Sprudel" contains only approximately 1 litre of gas, while the "Grosser Sprudel" contains over 3 c.c. per litre. The course of baths is always commenced with the springs weak in carbonic acid gas; indeed, at the start the waters are allowed to give off the whole of their gas before the bath is taken, while some "mutterlauge" rich in calcium chloride and bromine is added to them. Later a spring the water of which is richer in CO_2 is used, and this is gradually increased until strong carbonaceous waters flowing continuously in and out of the bath are employed ("Sprudel strombad").

The action varies with the temperature and degree of carbonization of the water employed. Small bubbles of gas adhere to the skin of the patient, which is powerfully stimulated thereby and becomes reddened. There is a sensation of heat and prickling and some degree of hyperasthesia. The cutaneous vessels ("peripheral heart") become surcharged with blood, to the relief of the chronically overloaded and halting ventricles.

One of the advantages of this bath is that it can be given practically anywhere by means of the artificially prepared

water. There are several good preparations on the market for this purpose, among the best known being the "Croyden," recommended by Bezly Thorne, consisting of bicarbonate of soda and acid sulphate of soda tablets.

These preparations are put up in boxes containing four packets of bicarbonate of soda and eight tablets of acid sulphate of soda. Eight parts of the former exactly neutralize twelve parts of the latter, but the alkali should always be in excess. Thirty-two ounces bicarbonate of soda, with 22 ounces of acid sulphate, will make a good bath of 40 gallons, and will generate about 250 c.c. of gas per litre of water. A whole packet of Sandow should be added to 40 gallons of water containing about 10 pounds of chloride of sodium and 10 ounces of chloride of calcium to make a *strong* bath.

At the commencement of treatment, however, where no effervescence is desired, the bath can be made up with 4 pounds of chloride of sodium and 6 ounces of chloride of calcium. Later, half a box may be added to this, and later again a whole box used with the stronger brine. The material for the brine can be easily obtained from the Salt Union at Nantwich.

The temperature of the water varies from 36° C. to 30° C., beginning at the higher temperature and being gradually lowered.

Carbonic acid gas is best obtained in large institutions and hospitals by means of the special apparatus of the Fischer Kiefer Co. of Zurich (Fig. 74). This produces a more even carbonization of the water than is possible with powders, but is, of course, too elaborate and expensive a method for private houses. An enterprising medical man we know obtained his CO_2 by means of the plant of an aerated water manufacturer whose premises adjoined his own!

Technique of the Bath.

The patient should recline at an angle of about 45 degrees, with his entire body up to the head and neck immersed in water (Fig. 74). The bathroom should be well ventilated,

and the patient should breathe regularly, abstaining from conversation.

Some sense of oppression is commonly felt at first, but will soon pass off if the patient takes two or three deep inspirations, "which facilitate the passage through the pulmonary circuit of the blood which is being driven through the right heart from the splanchnic and other venous reservoirs." The patient must leave the bath at the exact time prescribed, and be at once enveloped in a warm bath towel, and carefully rubbed dry by the bath attendant. He should then lie down on a couch in an adjoining apartment, and rest for at least an hour before dressing.

The duration of the bath and the strength of the constituents must vary with each individual and the stage of treatment. In many cases careful observation on the part of the physician himself is desirable.

The baths are usually taken in a course of twelve, and rarely should more than three be taken in each week. On the days on which there is no bath the patient is put through the Schott-Nauheim exercises.

The Effect of the Baths and Exercises on the Circulatory Organs.

In all conditions dependent on arterio-sclerotic changes and atheroma, such as commencing aneurism, congestion of the abdominal viscera, and imperfect emptying of the heart, if the tissue changes have not passed beyond the reach of repair, frequently relief and sometimes cure may be afforded by the suitable use of the Schott-Nauheim system. It has, indeed, been proved beyond reasonable doubt that early conditions of arterial degeneration can be greatly ameliorated by this method of treatment, and to a much greater degree than can be effected by any known drug or combination of drugs. By this treatment the heart is stimulated to more complete systole, and residual blood is expelled, while the peripheral resistance in the circulation is diminished. Benefit is always derived where it is to the advantage of the patient to restore healthy substance and proportionate working capacity to the myocardium.

The beneficial action is only limited by the degree of obstruction in the nutrient arteries and the degeneration of their coats. If these changes are far advanced, then increased force in the cardiac systole will only accelerate the degeneration and hasten the end. While reparative processes take place with readiness in the coronaries and the myocardium, organic changes in the valves from chronic endocarditis are beyond the range of any line of treatment.

It may be said that in valvular lesions the well-being and duration of life of the patient depend on the measure of compensatory hypertrophy and the absence of myocardial degeneration. This is probably more true of aortic regurgitation than of any other lesion.

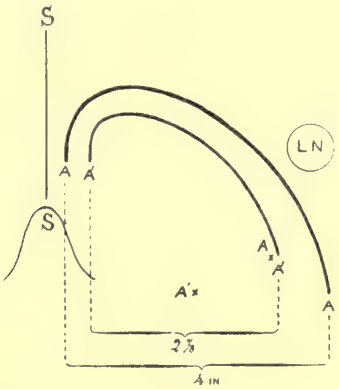


FIG. 72.—DIAGRAM OF CARDIAC DULNESS AS AFFECTED BY NAUHEIM BATHS.

In short, the Nauheim treatment is of the highest efficacy in establishing compensation in valvular disease of whatever nature, and restoring the myocardium to a healthy condition.

In cases of cardiac dilatation the diminution of the area of cardiac dulness is very striking. Indeed, Kellogg states that after one bath he has found the superficial dulness 1 inch less in its transverse diameter in cases of marked dilatation and loss of compensation.

It is well to keep a record of such cases by a simple diagram such as Fig. 72.

The Schott Brothers have also emphasized the value of the baths in this respect, having found a progressive and appreciable reduction in the area of cardiac dulness after a short course of these baths (Fig. 73).

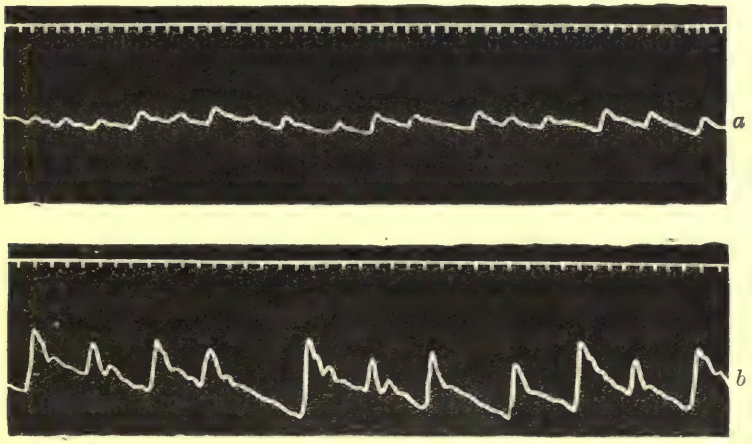


FIG. 73.—PULSE-TRACING: (*a*) BEFORE, (*b*) AFTER A FOUR-WEEK COURSE OF NAUHEIM BATHS.

The Schott-Nauheim Exercises.

Technique.—The body should be held upright and joints kept straight. The resistance applied should not be sufficient to cause any shortness of breath or tremor in the patient's limbs.

The resistance may be applied by the patient himself putting into action the opposing muscles to those which effect the movement, or by an attendant, commonly called "the operator." Each movement should be performed slowly and evenly, at a uniform rate, and not repeated twice in the same limb or group of muscles. The patient's breathing should not be accelerated, and any duskiness or pallor of the cheeks, yawning, dilatation of the alæ nasi, or drawing in of the corners of the mouth, must be taken as a signal for the immediate suspension of the movements. In order to prevent the patient closing the glottis and holding his breath, he should be told to keep counting in a whisper.

The Exercises.

1. The arms are to be raised slowly outwards from the side until they are on a level with the shoulder. After a pause they should be slowly lowered.

2. The body should be inclined sideways as much as possible towards the right, and then to the left.

3. One leg should be extended as far as possible sideways from the body, the patient steadying himself by holding on to a chair. The leg is then dropped back. The same movements are repeated by the other leg.

4. The arms are raised in front of the body to a level with the shoulder, and then put down.

5. The hands are rested on the hips, and the body is bent forwards as far as possible, and then raised to the upright position.

6. One leg is raised with the knee straight forwards as far as possible, then brought back. This movement is repeated with the other leg.

7. With the hands on the hips, the body is twisted round as far as possible to the right, and then again to the left.

8. With the hands resting on a chair and the back stiff and straight, each leg is raised as far as possible backwards, first one and then the other.

9. The arms are extended and the fists supinated. The arms are then extended outwards, next inwards, at the height of the body.

10. Each knee is first raised as far as possible to the body, and then the leg extended.

11. This movement is the same as No. 9, but with the fists pronated.

12. Each leg is bent backwards from the knee, and then straightened.

13. Each arm is bent and straightened from the elbow.

14. The arms are brought from the sides forwards and upwards, then downwards and back as far as they will go, the elbows and the hands being straight.

15. The arms are put at a level with the shoulder, and then bent from the elbows inwards and again extended.

16. With the arms in front at the level of the shoulder, and the hands stretched, the arms are opened out sideways and then brought together.

17. The arms are bent from the elbow outwards and extended.

Bezly Thorne enumerates the following conditions as suitable for Nauheim treatment:

Palpitation, with and without hyperpyesis.
The strained heart of athletes.
Cardiac dilatation, with "air-hunger" symptoms.
Petit mal (of the cardiac type).
Cerebral neurasthenia.
Tachycardia and bradycardia, exophthalmic goitre.
Cheyne-Stokes breathing dependent on arterio-sclerosis.

Summary of Action.—The primary effect in most cases is to reduce the pulse-rate by 4 to 6 beats per minute, while the pulsations are rendered more vigorous owing to the improved coronary flow. The cutaneous vessels become dilated and hyperæmic, while the internal vessels are contracted. The output of urine and CO_2 are both increased. There is a more complete contraction of the right ventricle, and increased vascular tonus throughout the whole circulatory system. There is a marked improvement in the general health and nutrition of the patient.

The opinions of some of the leaders in medicine on the subject of these baths are of interest. Douglas Powell says: "The employment of carefully graduated and observed exercises of Schott may be regarded as especially adapted for the treatment of the flabby, irritable, 'stuffy' hearts—cases of fatty infiltration and impaired metabolism—which are met with in people of venous plethora.

"In cases of chlorosis with dilated heart, after a preliminary week or two of complete rest, the Schott treatment is of value when combined with a chalybeate and a dry bracing climate.

"In the first commencing failure of heart in chronic valve disease, the treatment may be employed combined with a more or less complete cessation from other forms

of exercises, and similarly after such cases have been restored up to a certain point by digitalis treatment.

"Further, certain cases from the symptoms of which we recognize the presence of atheromatous changes in the coronary vessels, the treatment may be cautiously tried in combination with much rest. The treatment is undoubtedly an aid to our therapeutics."

Broadbent's opinion was as follows: "In cases of cardiac dilatation from loss of tone of the heart after influenza or some depressing disease, it may be of great service, and effect a cure where drugs and other treatment have failed.

"In many cases of functional and neurotic heart disease, which are commonly difficult to deal with, it may also give satisfactory results.

"In valvular disease, it is of course unnecessary when compensation has been established and no symptoms are present; when compensation has completely broken down it is not advisable to rest in bed, and suitable treatment by other means may be more efficacious.

"In cases of mitral disease, more especially mitral stenosis, when compensation is just maintained with difficulty, when the degree of stenosis is such that increased contractile power of the right ventricle induced by digitalis would be useless or harmful, it may be of great service. In aortic disease it is not advisable, owing to the risks of syncopal attacks, though when compensation is breaking down it may sometimes yield good results. In adherent pericardium, with threatened compensatory failure, it may be of service."

Professor Lindsay says: "I must confess I read with some incredulity the reports of rapid diminution of cardiac dilatation under this treatment, and I entertain no doubt that increased expansion of the lungs is the main factor in the alteration of the percussion area of the heart which has been described." While admitting slight experience of the method, Lindsay considers "the advantages consist in the methods employed being thoroughly systematized, controlled, and regulated."

Strumpell writes: "The employment of baths in heart disease deserves special consideration. Numerous ex-

periences go to prove that they are well borne, not only by patients with heart disease, but that they exercise peculiar and beneficial and invigorating influence on the action of the heart."

FIG. 74.—THE FISCHER KIEFER CO_2 GENERATOR FOR NAUHEIM BATH.

In view of the above there seems to be no room for scepticism or reasonable doubt that the use of Nauheim baths and exercises in many cardiac and associated conditions is in the clearest manner indicated.

Contra-Indications.—In cases with albuminuria due to chronic Bright's disease (large white kidney), it is better not to prescribe these baths.

They are also unsuitable when the patient is suffering from eczema, from angina pectoris associated with cardiac asthma, or from marked œdema or peripheral neuritis.

Peat, Fango, and Other Medicated Baths.

These are semi-solid baths of varying density and temperature; with them may be included the "hot sand" bath and the hot seaweed bath. They are used chiefly for their thermic and mechanical effects, but also to some extent for their chemical action.

Peat is a form of turf soil consisting of dried and decomposed vegetable matter which has undergone certain chemical changes induced by constant intimate contact with mineral matter percolating through it for thousands of years. Apart from dried grass fibre, root and bituminous substances, it contains silica, phosphate and sulphate of iron, sodium chloride, and sulphuretted hydrogen, as well as sulphuric and carbonic acid. After undergoing complete disintegration by exposure to the weather, the peat—by admixture with hot water—is made into a soft mush or mud, of the consistence of fine porridge, practically free from grit. The amount and nature of the chemical salts present in the peat from any district will, of course, depend on the nature of the springs in the district and the amount and quality of saline matter they contain. Sulphates, carbonates, and chlorides can be added to the hot water prior to mixing it with the peat.

The peat baths at Marienbad are ferruginous in character, and those at Driburg sulphurous.

Action.—A peat bath exerts a considerable mechanical effect, resembling that of massage, through compression and friction. The capacity of peat for retaining heat is much greater than water, and these baths can be employed at much higher temperatures than water baths. The motor and sensory cutaneous nerves are markedly stimulated.

Fango Di Battaglia.—Fango is the volcanic mineral deposit from the hot springs of Battaglia, near Padua. It has been used for centuries by the Italians for the relief and cure of painful affections, such as sciatica, lumbago, gout, rheumatism, etc.

Its value being recognized by visitors to Battaglia, it was imported to some of the Continental bathing-places, and its properties were tested under skilled and scientific observation. The results were so satisfactory that it has been gradually adopted at the principal health resorts, which now owe a great part of their success to the results of fango treatment. At Baden-Baden, Kissingen, etc., its use has greatly increased. The use of fango dates from very early times. Under the Roman Empire the applications of this material at the Eugean Thermæ were noted for their excellent effects.*

In appearance fango is a soft, greyish-brown, plastic substance of the consistence of butter, and equally soft to the touch. It is odourless, and after the application is finished can be quickly and completely removed from the skin by means of a douche of warm water, leaving the skin surface absolutely clean.

Chemical Analysis.—Fango is rich in iron, argillaceous earth, magnesia, lime, and alkalies, united with phosphoric and sulphuric acids.

	In 100 *Parts.*
Combustible and volatile matter	10·98
Soluble in acids	41·36
Insoluble	58·64

The portion soluble in acids is composed of—

Carbonic acid	9·34
Sulphuric acid	6·65
Silica	7·86
Oxide of iron	9·81
Phosphates	1·83
Carbonate of lime	6·05
Magnesia	1·40
Potassium, Sodium } as sulphates	0·94

* Fango baths were first introduced into this country at the bathing establishment connected with the Royal Hotel, Matlock Bath.

In addition, there are traces of the rarer minerals, such as thorium, helium, and radium.

In order to bring the fango to a proper temperature for application to the body, it is heated in a large water-jacketed or steam-jacketed pan. The temperature at which it is applied is a most important point, and it is essential that the heat should be easily controlled. The apparatus in general use is a large tinned copper pan with a lid. The pan is surrounded by a water chamber, and the latter is heated by a number of large gas Bunsen burners. The heating takes place but slowly, but the cooling is equally slow, and when once a large mass of fango is raised to proper temperature, it takes some hours to cool. The application is, indeed, a large sterilized mineral poultice enveloping the affected part (Figs. 75 and 76).

Temperature and Duration of Application.—It was at first thought important to obtain as high a temperature as possible in the fango treatment, but this was an erroneous idea. The following rules should be observed in a general way:

To begin with, a low temperature should be used, and gradually raised by a degree or so at a time. A low temperature for fango is 45° C.; the highest temperature endurable is 56° to 58° C., at which signs of burning show themselves. Generally speaking, a temperature of 54° to 55° C. is sufficient.

The higher temperatures are only useful in the treatment of deep-lying abdominal or thoracic viscera. For all kinds of neuralgias low temperatures (45° C.) are advisable. With old or weak patients the temperature should never exceed 49° C., and the packs be given only on alternate days. Packing should not take longer than thirty-five to forty-five minutes.

For washing off the fango, a warm douche or spray is recommended. General baths are not desirable. Neurasthenics, and those suffering from some other nervous complaints, usually require a cold douche after the warm one, followed by a rubbing down.

Reaction.—The patient should be warned at the commencement that a reaction takes place (and sometimes even

repeats itself). During the time of this reaction, which usually appears after a few applications, the affected part is frequently much more painful and sensitive. After a few more applications the pain subsides again, and usually a steady improvement sets in.

Fango treatment can be employed from infancy to old age, and with every constitution, even with such as suffer from severe heart complaints. Cases with high fever, advanced phthisis, or women who are *enceinte*, should not be treated with fango.

A very important point in fango, as well as in every other thermal treatment, is that the physician should keep a sharp eye on the patient, especially at the beginning, and see him after every third and fifth packing; and also that he adapts his prescriptions to the individual case.

The Action of Fango.—The action of fango must be considered in a threefold aspect: the chemical, the mechanical, and the thermal. The chemical effect has not yet been made sufficiently clear, and there are great differences of opinion concerning it. The mechanical effect consists in the pressure exercised by the layers of fango, which act like a gentle massage. The cause of the thermal action is, of course, to be found in the high temperature to which fango has to be brought; a balancing of the heat of the body and the heat of the fango takes place, and the body remains always under the same warming layer.

The physiological effect of fango applications on the blood-pressure, the distribution of the blood, and on the heart, may be shortly expressed as follows: According to many observations the frequency of the pulse is diminished at the beginning of the application, becomes greater after about ten minutes (an increase of 6 to 8 per minute), then diminishes again by 2 to 3 per minute, and after this remains stationary until the end of the application. The application is immediately followed by an increased tonus of the blood-vessels, this being the consequence of the irritation of the vaso-constrictors; the skin becomes pale; the blood-pressure is heightened for a short time; then a hyperæmia of the cuticle takes place through paralysis of the constrictors, and with it a reduction of the heart action in consequence

of diminished resistance. According to Baelz, this paralysis is not annulled by cold, and patients could leave the bathing-house undressed, even in winter, without catching cold.

The reflex action of the sensory and temperature nerves on the heart is kept up; a douching with cold water is at once followed by a decrease of the number of pulse strokes, and by a strengthening of the heart action, without diminution of the redness of the skin. Baelz noticed also that the blood of anæmic patients is greatly improved after a fango application. The temperature of the body is heightened during the application, particularly during the first quarter of an hour (1° to 1·5° C. or more). According to Maggiora and Levy, this is not so much the result of a lessening of the radiation of heat as of a direct heating of the blood through the far hotter fango. In the beginning of the application a diminished frequency of respiration is observable, which increases after about ten minutes by four or five breaths, without being followed later on by oppression or deeper breathing.

A fango application does not relax the muscles, and very little fatigue is subsequently felt. An increased secretion of nitrogen can be proved either in the perspiration or in the urine. Gout especially produces an increased secretion of uric acid. The action of fango on the nerves differs according to the temperature employed; it either promotes, hinders, or altogether stops their action. The physiological facts justify its employment in the following ways: Fango is, *first*, the best cataplasm known. Its density, its even consistency, its low specific heat, the fact of its being a non-conductor of heat, and the mild counter-irritation it produces on the cuticle, permit it to act for a long time on a considerable area of the body, even when brought to a high temperature, without substantially disturbing either the pulse, the blood-pressure, or the heart action, without producing congestions and oppressions, or leaving behind (like other kinds of baths) a great feeling of relaxation and fatigue. *Secondly*, fango is an excellent diaphoretic.

Through its action on the distribution of the blood in the organism fango has a diverting effect, while in the cuticle it produces hyperæmia. In both cases the effect

is an intensive, passive one, with diminished tonus of the vascular system of long-continued duration. We are therefore able not only to effect a momentary lessening of congestion in cases of hyperæmia of the inner organs as well as of the mucous membranes of the respiratory and intestinal tracts, and in hyperæmia of the brain and its membranes, but the effect endures, and by a methodical continuation of the treatment the vessels of the affected parts will by degrees resume their normal tonicity and fulness.

On the other hand, fango applications produce an increased supply of blood of a higher temperature, with consequent perspiration, in rheumatic affections of the joints and of the nerves, and in this manner they promote the resorption of all sorts of effusion, and particularly of perimetritic exudate, as well as gouty deposits, etc.

Combined with a suitable diet, fango treatment is of great advantage in affections of the intestinal tract, especially in chronic catarrh of the bowels.

Rheumatism, Subacute or Chronic, will always be one of the chief indications for fango treatment. The results obtained are completely successful. Cases usually come under treatment after having suffered some time. The reaction may take two or three days, and according to its intensity the doctor will continue or discontinue the pack for two or three days, or else lower the temperature. After a thorough improvement has taken place it is advisable to give five to ten more packs, so as to prevent a relapse.

Chronic Articular Rheumatism (in all its Stages.—The greatest field for fango treatment is offered by this complaint. The packs are first applied at 46° C., the temperature being increased by about 1° daily till 53° to 54° C. is reached. In this complaint the temperature should be increased in spite of the reaction, which takes place usually after the second until the sixth packing, and lasts from two to five days. Only with a very acute reaction should the temperature be lowered. In the general course of treatment, reactions often take place later on. These are usually rather intense, but do not last more than a day or so, and generally announce a new amelioration.

If the joint becomes swollen by fluid effusion, skilful massage may be required. Often rather large synovial effusions, occurring during the first few packs, go down after a little time by merely continuing the packs. As a rule, use massage in cases where it appears to be called for (*e.g.*, in contractions and thick old effusions) only after the reaction, and call the attention of the patient to the fact that an increase of pain may at first result from the massage.

Rheumatoid Arthritis.—Massage is generally given from the beginning, except where the joints are very painful. An improvement almost invariably takes place, the intense pains are alleviated, and for a time they may disappear entirely. The treatment should be of longer duration, and repeated at intervals of six months at least.

Muscular Rheumatism.—The fango is applied first at 47° C., and gradually raised as high as bearable. Reaction is rapid and brief, and recovery usually quickly follows.

In old and chronic cases, such as lumbago, the reaction is delayed, occasionally not appearing till after fifteen or twenty packs, but the case then makes satisfactory progress and the lumbago is often banished for years. Occasionally patients complain that the pains wander from the back to the thigh or chest, etc. The application should follow up the pains, which gradually diminish, disappearing last at the place where they began.

Old Injuries.—High temperatures can nearly always be prescribed from the first.

Neuritis.—In all applications to painful nerves low or moderate temperatures must be employed, beginning at first as low as 40° to 43·3 °C., and for ten minutes or so only. Each case must be judged by itself, for there are few in which excellent results are not obtained if sufficient care be taken. Occasionally there are inveterate cases of sciatica that show no signs of improvement, even after prolonged applications.

In these cases, if no reaction has taken place after a few packings, the reaction must be enforced. This is done by applying two or three packs at 54·5° C. When the reaction

occurs, lower the temperature to 46° C., and let it remain at this. As soon as the pain lessens, the packs should be applied every other day, and later twice a week.

Alcoholic neuritis (multiple) may be successfully treated with fango.

Abdominal or Pelvic Neuroses.—High temperatures are most useful here. The whole abdominal, lumbar, and sacral regions are treated. This is mostly of service in gynæcological patients.

Tabes Dorsalis.—For the shooting pains, four or five packs, applied every second day, often produce a very satisfactory result. The pains diminish, and often disappear entirely.

In chronic bronchial catarrh, pleuritic effusion, abdominal diseases, gall-stone colic, and pelvic disorders, the highest temperatures must be used.

Gout.—In acute gout fango is especially useful; it allays the pain and reduces the duration of the attack. After three or four days improvement sets in, and by the seventh day an excellent result is nearly always produced, whilst otherwise the patient would have had to stay in bed or on an easy chair for three or four weeks. In forty cases of acute gout we had only one where the effect was not so prompt.

Sand Baths.—The body, or a portion of it, is immersed in sand heated to a temperature of from 42·4° to 54·4° C. Profuse perspiration results, with reddening of the skin upon which the sand cakes.

The body temperature rises 3° or 4° degrees, owing to delayed heat loss. These baths are used at Harrogate and at Lavey, in Switzerland.

The sand was formerly warmed by exposure to the sun, but is now usually heated in special ovens. Fine hard sea or river sand is used. The heated sand is laid for a depth of 6 to 12 inches on the bottom of the tub, and the patient lies down in this. His head is raised on a pillow, and the body carefully covered with warm blankets.

The temperature of the sand to begin with is from 45° to 50° C., and may be maintained by means of hot pipes in the floor of the tub. Perspiration rapidly occurs,

FANGO TREATMENT.

FIG. 75.—APPLICATION OF THE FANGO.

FIG. 76.—"PACKED UP."

and is freely absorbed by the sand, so that the patient experiences no discomfort. Pulse and respiration are quickened.

Duration, one to one and a half hours. The patient is treated as after the steam cabinet or Turkish bath.

Indications.—These baths are specially indicated, in preference to vapour or water baths, where a powerful skin stimulation with increase in body heat is desired. They are of service in various joint affections of a gouty or rheumatic nature, in neuralgia, peripheral neuritis, and in chronic inflammatory affections of the uterus.

They should not be given to patients who are suffering from cardiac disease of an organic nature, phthisis pulmonalis, or to pregnant women.

Brine Baths ("Sool-Bader").—These baths are prepared from water containing sodium chloride, or by adding saline to ordinary water. Powders may be used which are prepared from suitable mineral waters by concentration.

The salts are chiefly chlorides of sodium, magnesia, and calcium. From 15 to 20 pounds are necessary to make a full bath to contain 3 per cent. The bath water should contain not less than 1·5 per cent. of saline matter, and the amount may be increased up to 5 or 6 per cent. The usual temperature of the bath is 35° C.

The action of these baths depends chiefly on the irritative effect of the saline matter on the patient's skin, which is rendered somewhat hyperæsthetic. Production of CO_2 is increased and the blood-pressure rises. The baths possess a somewhat diuretic action, and the urea and chlorides are excited and increased. The effect is greatest if the saline percentage of the bath be low. With the increased metabolism the patient's appetite improves.

Indications.—These baths are of value in the treatment of various chronic inflammatory disorders of the pelvis in the female, such as perimetritis and parametritis, in chronic joint rheumatism, and neuritis.

Medicated Baths.—Vegetable, animal, or mineral matter are added to the water in these baths in order to modify their action in various ways. Among the substances employed are dried plants, such as camomile, thyme, spearmint,

lavender, oil of cade, etc. An alcoholic extract of these is added to the bath water.

Peat Baths.—These are used at Buxton, Strathpeffer, and Harrogate in England—very largely at the latter place, the weekly consumption of peat in the season being 25 tons. The peat at Harrogate is obtained from Goole, near Hull, and is peculiarly free of organic matter. The preparing of the bath is rather an elaborate process, and requires a lot of labour, hand and mechanical. The peat is first chopped up finely and run into bins containing sulphur water, brine,

FIG. 77.—PEAT BATH.
(Harrogate).

and plain water. Revolving blades in the bins further break up the peat and thoroughly mix it up with the waters. It is then run through piping controlled by valves into the bath tubs underneath, and heated there to the required temperature by means of steam. Evenness of temperature all over is secured by further careful mixing, and the temperature is checked in various parts of the bath. The bath tub is then run through from the preparation chamber into the actual bathroom through a sliding door. The patient

lies in the peat mixture for the prescribed period, varying with different cases, but seldom exceeding forty-five minutes, and then is roughly swilled down and put through a needle bath from hot to cold. He is then packed with towels and sheets until he is quite cooled off.

The bath tub is run back out of the bathing-room, emptied, and scalded out for the next patient, for whom, of course, fresh peat has to be used. It will be observed that the amount of haulage and labour involved is very considerable. So popular are these baths at Harrogate, however, that sixteen are in regular use, and more are to be shortly added.

SECTION III

CHAPTER I

MASSOTHERAPY

MASSAGE, or massotherapy, consists in the treatment of various forms of disease by systematic manipulations. The derivation of the word is from the Arabic *Mass'h*, to press softly, the Sanscrit root being *makch*. There is a Greek word, *μάσσω*, meaning to handle or knead.

Massage is a very ancient form of treatment. In Chinese manuscripts allusions to it will be found dating back to a period as remote as three thousand years before the Christian era, and there are oral traditions of even greater antiquity. The manuscript, *Kong Fao*, the date of which is 3000 B.C., contains detailed accounts of the various manipulations. The practice seems to have been common to Celestials, Persians, Greeks, and Romans. Much information in regard to the early history of massage is found among the writings of Celsus, Galen, Hippocrates, Oribasius, and other ancient writers.

Hippocrates says: "A physician must be experienced in many things, but assuredly also in rubbing, for things which have the same name have not always the same effect; for rubbing can bind a joint that is too loose, and loosen a joint that is too tight. Rubbing can bind, can loosen, can make flesh, and can make parts to waste. Hard rubbing binds, and soft loosens."

The Romans frequently employed massage after their bath, just as we employ the "shampoo" after the Turkish bath at the present day; and after the circus fights it was employed to restore sprained and stiffened joints to their normal flexibility and suppleness. Homer tells how women

rubbed and anointed veterans after the toil and stress of battle.

A few years ago massage was so vaunted and exploited for commercial reasons that medical men were inclined to regard it with considerable scepticism and suspicion. It has, however, stood the test of time, and we know at the present day that it is a reliable and powerful therapeutic agent. The advertising "rubber" professes that it will cure almost any ill that flesh is heir to, from obesity to consumption; on the contrary, its sphere of action is in most hands comparatively limited. Carried out under the direction of a trained and scientific physician, it may, however, yield brilliant results in numerous conditions obdurate to the action of drugs.

Some medical men have a very limited and unfortunate conception of the process. They call it "rubbing," and think that any able-bodied and active man or woman can master the technique in a few lessons and proceed to "rub" with good results. This is far from the truth. Considerable training and aptitude are needed, and at least an elementary knowledge of anatomy is essential. In the Ling School, in Stockholm, the course of training, which also includes medical gymnastics, occupies a period of five years.

It must be admitted that women are more skilful and successful at massage than men, especially in "rest cures"; their touch is more delicate, their hands softer and more flexible. There are, however, unquestionable objections to the application of general massage by a member of one sex to the other. Indeed, it is in connection with this very question that massage fell some time ago into such disrepute.

To the blind, above all, is granted the "*tactus eruditus*," and in Japan massage is regarded as peculiarly their province. With this idea they have been trained from time immemorial, and until recently none but the blind were so engaged. Of late years, however, people possessed of their sight have entered the arena, and the competition has become very keen in spite of the low rate of remuneration.

To acquire a good knowledge of massage, pupils, having

gone through a course of good general education, spend from three to five years in the schools for the blind. When found to be an efficient masseur, the blind student either takes a post in one of the schools as teacher, or starts on his own account as a private masseur. In Yokohama, with a population of half a million, there are no less than 1,000 men and women engaged in the practice of massage, of whom 900 are blind; 400 of these belong to a guild, and 600 are working on their own occount.

General Rules.

The part to be treated should be placed in a posture of complete repose, with the muscles quite flaccid. It is impossible to apply massage to muscles in a state of active contraction.

The entire limb should be in the same plane, or with the distal portion somewhat higher than the proximal, and the manipulations are always carried out in a *centripetal* direction, commencing at the most distal point and moving towards the trunk.

General massage is conveniently carried out with the patient lying on a bed, or on a couch of 27 to 30 inches in height.

While pétrissage and tapotement can be quite well performed with the patient's clothes on, it is best to remove all clothing and have the patient warmly covered with blankets, except the actual part under treatment.

To avoid skin irritation some oil or vaseline is sometimes used; a purified petroleum oil, such as "Dee oil," is best; but unless the skin be unusually dry and hard, they can all be dispensed with; and if any lubricant be used, boracic acid will often suffice. The better the masseur, the less adventitious aid of this nature will he require.

The duration of the séance will, of course, depend on the nature of the case; the tendency is to give too long a time. For any joint, limb, or special region, ten to fifteen minutes is ample. When general massage is required, a period of thirty to forty minutes will be necessary; and in Weir Mitchell cases up to one hour twice daily.

While the methods of different operators will vary somewhat, the following manœuvres are universally employed:

Effleurage, or Stroking, is a gentle stroking or rolling of the skin, gradually increased to moderately firm friction, always in a centripetal direction (Fig. 78). In dealing with small areas the palmar surface of the masseur's fingers are employed, while over large surfaces the whole surface of the palm of the hand is applied to the skin. Sometimes the ulnar edge of the hand is employed in preference.

Each stroke commences from the most distal point on the extremity under treatment. In the up-stroke the pressure applied is somewhat firm, while in the down-stroke, which should be absolutely continuous, less pressure is exercised. From start to finish of each movement the

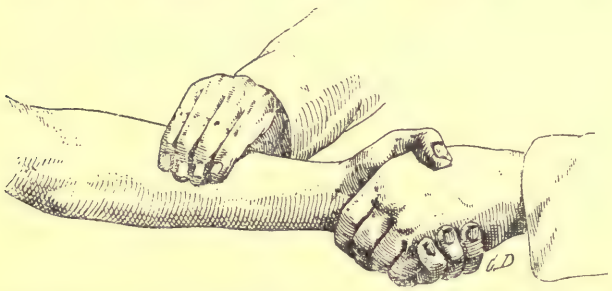


FIG. 78.—EFFLEURAGE CARRIED OUT WITH THE FINGER-TIPS.

hand of the operator does not leave the patient's skin. The rapidity of the stroke varies with the effect which it is desired to produce. Rapid, brisk strokes of about one hundred per minute are stimulating, while slower and firmer strokes of seventy to the minute, or less, are soothing in effect.

Pétrissage, or Kneading.—This is one of the most valuable manipulations, as well as one of the most difficult to carry out properly (Fig. 79). The skin and muscles are grasped and kneaded seriatim from the peripheral parts to the centre of the trunk, the hold being alternately tightened and loosened.

It is of the utmost importance that neither the skin nor the hairs are dragged on, for this is very painful at the time, and often causes a crop of boils to form later which

will for the time being necessitate the entire suspension of the massage. In dealing with the larger groups of muscles, such as the quadriceps extensor groups, it is well to use both hands simultaneously (Fig. 83). It is sometimes possible

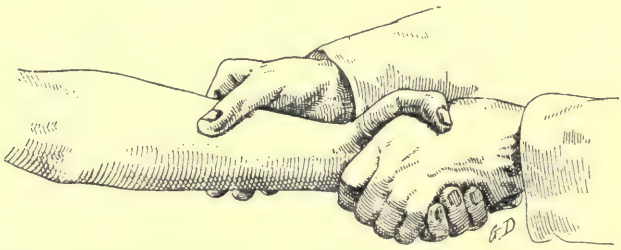


FIG. 79.—PÉTRISSAGE WITH A SINGLE FINGER OR THUMB TO REMOVE INFLAMMATORY EXUDATES.

in this way to deal with the muscles on either side of a limb at the same time, and roll the muscles against the bone. This special manœuvre is known as "fulling," from its similarity to the movements of the fuller in linen bleaching.

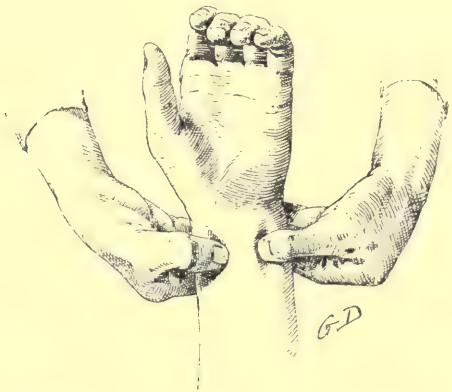


FIG. 80.—PÉTRISSAGE OF THE FOREARM WITH BOTH THUMBS.

Tapotement, or Tapping.—This consists in a series of blows struck in quick succession, either with the fingers, the edge of the hand, or the whole hand (Figs. 81, 82). The blow should be staccato in character, coming from the wrist, rapidly delivered with a certain rhythm. To pro-

duce a superficial effect the fingers only are used, while if we wish to act on the muscles and deeper-lying structures, a series of chopping strokes are given with the ulnar edge of the hand along the whole length of the muscle in its transverse axis. Bearing in mind that the object is to produce a slight mechanical stimulus, and not a painful impression, care must be taken that, when the whole hand is used, what is intended to be a sharp blow or stroke does not degenerate into a smack. No pain or bruising should be produced. When the ulnar surface of the hand is used (Fig. 82), the fingers should not touch the patient's skin, and the blow

FIG. 81.—TAPOTEMENT WITH THE DORSAL SURFACE OF THE HAND.

must come from the elbow-joint. To successfully carry out this manipulation some delicacy of touch is requisite, and also considerable manual strength.

Friction Massage.—This consists in rubbing small circles from the peripheral parts centripetally, using the whole hand, the thenar eminences, or the finger-tips, according to circumstances. It is of especial use in treating joints and any region where kneading is impracticable.

Vibration.—This is in some respects a combination of the two preceding manipulations (Fig. 85), a vibratory or

shaking movement being added to them. It is probably, of all the different massage manipulations, the most difficult to acquire, and it is the only one which can be with advantage carried out by mechanical means (see "Mechanical Vibration").

FIG. 82.—"HACKING"—A VARIETY OF TAPOTEMENT.

FIG. 83.—PÉTRISSAGE OF THE ARM MUSCLES WITH VIBRATORY MOVEMENT.

General Massage.

While it is immaterial whether we begin with a foot or with the upper extremity, it is well as a matter of routine to follow a regular order; for instance, legs, arms, chest, abdomen, and back.

The patient, except for the last-named region, lies in the supine position throughout, with only so much of his body exposed as is actually under manipulation.

Massage of one extremity is much like another, so that what is said of the lower extremity will in large measure

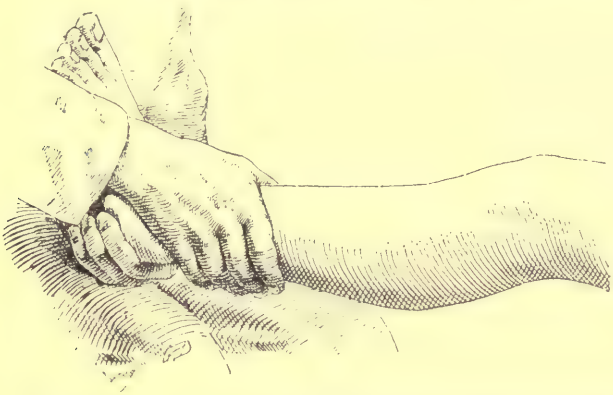


FIG. 84.—EFFLEURAGE PERFORMED WITH THE ENTIRE PALM OF THE HAND RAPIDLY MOVED TOWARDS THE KNEE.

apply to the arms. If the hair of the patient's skin be long, it may save much pain and trouble to shave the leg close, or at any rate crop it with scissors.

If the left extremity is to be manipulated, the masseur will stand at the patient's right. At the commencement each toe is flexed and extended two or three times; then the ankle, knee, and hip-joint, etc. The patient's left foot is taken in the masseur's left hand, while with the right hand on the dorsal surface he strokes towards the ankle. The sole of the foot is then kneaded with the fingers, and then the skin around the malleoli and tendo Achillis with the thumb and fingers.

In treating the leg, the patient lies upon his right side,

while the masseur is seated. Resting the patient's heel on his knee or thigh (Fig. 84), a few steady strokes are made upwards from the level of the ankles.

The muscles of the calf are then thoroughly kneaded, and then the muscles on the anterior aspect of the leg are similarly dealt with. If the leg is large and fleshy, the more superficial layers of muscles are pressed and kneaded against the deeper layers ("fulling"); a little light effleurage then quickly concludes the treatment of this region.

FIG. 85.—ROTATION OF THE FOREARM MUSCLES.

After stretching the skin around the knee and applying a little friction, the thigh is dealt with. Effleurage is first applied to the whole thigh and hip. Pétrissage is then applied to the large groups of muscles—quadriceps cruris and adductors—both hands being used at the same time.

The movements must pass from below upwards. Effleurage is used at the finish as usual. The patient lying on his right side, effleurage is then carried out around the head of the hip-joint; with the operator's right hand the short muscles around the trochanter are then carefully kneaded.

In dealing with the upper extremity, the hand is manipulated in much the same manner as the foot; the thenar

and hypothenar eminences are thoroughly kneaded and finished with effleurage, which is continued up the forearm; the wrist, elbow, and shoulder-joint are then freely flexed, extended, and circumrotated.

Holding the patient's left hand in his right, the operator thoroughly kneads the muscles of the forearm on its anterior and posterior aspects. Similar treatment is then carried out on the upper arm, finishing with the shoulder-joint.

The Chest.—The pectorals are treated with kneading movements and tapotement (sometimes), and effleurage carried out over the rest of the surface of the chest, the posterior surface remaining over until the back is treated.

The Back.—The patient having been comfortably arranged in the prone position, friction and kneading is applied to the back of the neck. Effleurage follows along the whole back, somewhat rapid and vigorous in character. Thumb and finger kneading is applied to the erector spinæ and deep muscles of the back, and following this the muscles of the hips and buttocks are thoroughly kneaded. Rapid effleurage of the whole surface of the back is now performed, with very quick stroking of the skin over the spine, which becomes reddened.

Massage of the Stomach.—The object of gastric massage is twofold—viz., to increase the motility or contractile power of that organ in atonic conditions, and at the same time increase the quantity and quality of the secretion. Massage, properly carried out, will always increase the acidity of the gastric juice, except when the absence of hydrochloric acid is due to malignant disease. The gastric tenderness often present in hyperchlorhydria will often prevent the performance of gastric massage, and this is well, seeing the condition would for the most part be aggravated by such manipulation. In all cases of diminished acidity, however, massage is helpful.

To reach the comparatively limited area of the stomach wall that is accessible to touch, in the first place the patient must be thoroughly relaxed, and deep manipulations be used (Fig. 86). Any rigidity of the abdominal muscles will make the manipulation impossible. If relaxation cannot

be obtained with the patient in the usual supine position, with raised head and drawn-up knees, he should be asked to turn on his right side, and the masseur work from behind him.

Deep kneading and shaking, followed occasionally by vibration and slapping, are the movements most commonly employed. The séance usually lasts ten minutes, and the treatment is well given about half an hour after food.

In cases of atony and defective motility, when it is desired to aid the removal of the gastric contents through

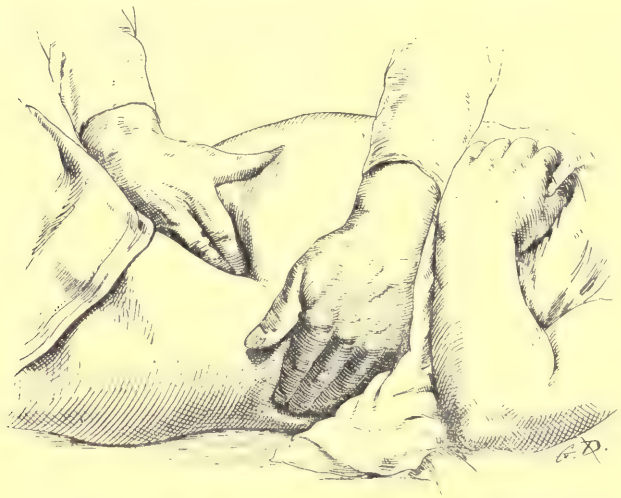


FIG. 86.—MASSAGE OF THE STOMACH.

the pylorus, after preliminary effleurage and kneading, the masseur should stroke firmly from left to right across the stomach with the whole surface of the right hand, getting the thenar eminence well in under the left ribs, and then slowly moving across in a somewhat downward direction. It is possible in a few minutes to get rid of a large amount of food débris through the pylorus by means of this movement if efficiently carried out.

Massage of the stomach is too often superficial, and the defectively trained masseur soon reveals himself by rubbing in the wrong direction.

Massage of the Abdomen.—Before commencing, the patient should always see that the bladder is empty, and if possible an action of the bowels should be obtained.

In order to get the muscles completely relaxed, the patient's head and shoulders are elevated, his knees flexed, and a request made that he breathe deeply and regularly. The greatest difficulty is met with in getting the proper degree of relaxation in nervous individuals, particularly women. A little patience, and chatty conversation to distract the patient's mind, will generally overcome this difficulty after a few minutes.

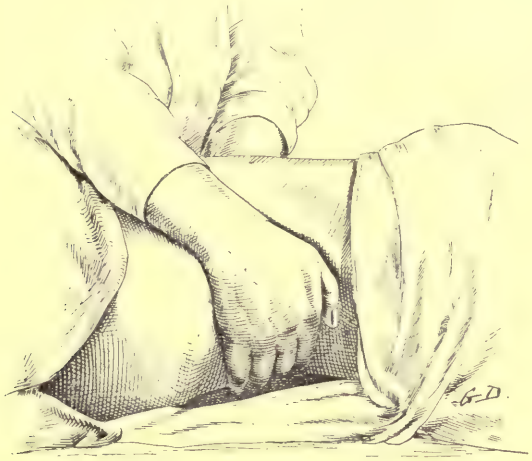


FIG. 87.—MASSAGE OF THE ABDOMEN.

In commencing, the masseur puts both his hands underneath the patient (Fig. 87) until they meet in the lumbar region, and then draws the hands forwards, compressing the patient's flanks, and at the same time lifting somewhat until the hands again meet in the mid-line of the abdomen.

Deep kneading is begun on the right iliac space with both hands, and the entire abdomen is thoroughly kneaded several times from the right to the left side. The left iliac space is treated in the same way, and the colon is followed throughout its entire course (Fig. 88) and treated with digital kneading. More general and heavier manipulation

may be carried out with the thenar eminence and fist in patients who are tolerant of such manipulation. The concluding movement is light pressure of the abdomen with the whole of the operator's hand, to which he then imparts a vibratory movement.

A very poor substitute for good abdominal massage is the shot bag—a stout canvas bag containing small shot—which is moved about the abdomen, over the course of the colon, etc., by the patient himself. A similar appliance is

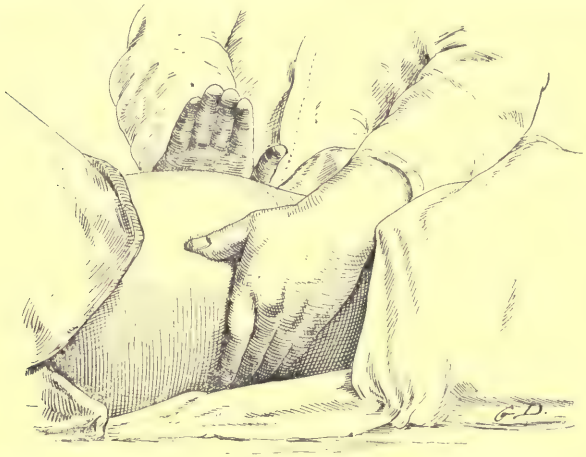


FIG. 88.—MASSAGE OF THE ABDOMEN FOLLOWING THE COURSE OF THE COLON.

Sahli's iron ball. Such massage is, of course, elementary in the extreme; but in cases of constipation, where the genuine article is not available, either from expense or other reason, these manipulations are sometimes of service.

The General Effects of Massage.—After the conclusion of each séance the patient should be warmly covered up and allowed to rest for upwards of half an hour.

A sense of drowsiness is often experienced, and the patient may fall asleep. In a few days he will find his appetite improving, his sleep to be sounder, and his general condition improved. The skin becomes softer, more elastic and glossy, and fresher in colour. The veins are more distinct, and there is finally improved tactile sensation,

although the immediate effect of massage is to somewhat deaden sensation. Von Mosengeil demonstrated by injecting solutions of Indian ink into rabbits' joints that the rapidity of absorption was much increased by massage. He applied massage to one side, and not to the other, and found that on the treated side the lymphatic glands in the vicinity of the joint were soon full of particles of Indian ink.

The muscular tone is more rapidly restored after fatigue by massage than by mere resting, and the muscles respond more readily to electrical stimuli. Waste and fatigue products are removed from the muscle tissue, and new nourishment introduced, and the patient soon puts on weight owing to the increased nitrogenous metabolism.

The force of the cardiac systole is increased by massage of the limbs, and the blood-pressure raised. On the other hand, abdominal massage tends to some degree of vascular hypotonicity and generally lowered blood-pressure. The respirations are increased in both depth and frequency. The red blood-corpuscles are notably increased, both in the healthy person and in the anæmic, after a course of massage; there is not, however, a proportionate increase in the amount of hæmoglobin. Both the peristalsis of the stomach and its secretory power are markedly stimulated by local massage. Intestinal peristalsis is also increased, while the activity of the liver is similarly affected.

The temperature of the whole body is temporarily raised about 1° C., but rapidly returns to the normal.

Therapeutic Indications.—*Dyspepsia and Constipation* are frequently markedly relieved by judicious massage. In the former condition it is of special importance to see that the massage is not out of proportion to the amount of food which the patient is taking—*and assimilating*. If caution be not observed, weight loss is easily increased. As the appetite improves more food is consumed, and with improved assimilation the duration of massage can be slowly increased.

In constipation the massage should be applied in the early morning before the patient dresses, so as to induce a healthy action of the bowels at the usual time. Both the abdominal muscles and the intestinal wall should be in-

fluenced. Beginning in the region of the cæcum, the operator should work up the right side of the abdomen, along the transverse colon, just above the level of the umbilicus, and down the left side (see Fig. 86).

After superficial movements have been performed, the pressure should be increased, and the hands given a rotatory motion and made to follow the line of the colon.

The abdomen should be so treated for about fifteen minutes daily, and the treatments kept up for a month or six weeks, according to results. The movements can later be imitated by the patient himself by means of the "shot-bag," though, of course, this is much inferior to manual treatment.

Insomnia is commonly greatly benefited by general and abdominal massage, which should, however, be applied late in the day.

Joint Affections.—Various sprains and synovial inflammatory conditions are much improved by massage. The most striking results are seen in cases where the joint has become stiff and useless from disuse, and the muscles atrophied. In these cases initial breaking down under an anæsthetic is often required. Chronic rheumatoid arthritis, while somewhat helped, is less yielding to the application of massage than gout or gonorrhœal rheumatism.

In these conditions active treatment for ten to fifteen minutes twice daily should be kept up, combined with various hydrotherapeutic applications.

Generally speaking, acute inflammatory joint conditions are best left alone by the masseur. At the same time, in acute cases gentle manipulation may be begun very early after the injury.

Nervous Affections and Myalgia.—In obstinate sciatica local massage may be of great service; an initial "dry stretching" is often indicated, then kneading of the muscles and skin stroking.

Other forms of neuritis are equally benefited. Rheumatic and gouty myalgia, lumbago, etc., frequently yield in a few days to this mode of treatment. In regard to the muscles, it must also be borne in mind that when a patient has been compelled to keep his bed for some weeks, owing to a fracture

or some illness, convalescence and ability to walk are much helped by applying massage to the limbs a week or ten days prior to getting up.

Other conditions in which massage is indicated are anæmia, obesity, drug habit, chorea, and neurasthenia.

Local manipulation of the uterus, etc., in subinvolution and similar conditions, is essentially objectionable—nay, disgusting—when performed by physician or masseur; hardly less so when carried out by a masseuse.

Conditions not Benefited by Massage.—The indiscriminate use of massage is to be strongly condemned, for there are numerous conditions for which it is perfectly useless, and not a few when it is absolutely hurtful and even dangerous. Instances of the latter are, in general massage, venous thrombosis, and in abdominal massage, severe gastric ulcer.

In febrile conditions the temperature is further raised; in acute renal disease or pulmonary tuberculosis it may induce a hæmorrhage. It may, however, be employed in phthisis during a quiescent period. Abdominal massage should never be employed when the patient is menstruating or pregnant.

Common sense will negative the use of massage where there is any considerable solution of continuity in the skin of the patient, be the immediate cause a burn, an ulcer, or a cut. In any dermatitis, of course, harm will be done and the condition be aggravated by massage.

Vibration.

Vibration may be done by the hand or mechanically. Probably hand vibration is about the most difficult movement to carry out effectively, and requires very considerable skill and training. Long practice is required to attain any degree of speed, and it is necessary for the operator to be trained how to breathe when doing it, otherwise he is inclined to hold his breath and exhaust himself very quickly. Practice is best carried out by placing the tips of the fingers on a table of moderate size in the middle of which a glass of water has been placed. If the vibrations are practised

properly, the waves of the water run towards the surface of the glass; if they are clumsily performed, the water will sway from side to side in a mass.

Practice should be carried out daily, or the masseur loses his skill; but too long spells must not be taken, or a sort of occupation spasm comes on similar to writer's cramp. It is equally difficult to cure.

With all the necessity for training and the risk of overuse, it is not to be wondered at that mechanical vibrators have largely taken the place of manual treatment. The most expert masseur cannot exceed 600 vibrations per minute, and the number quickly falls after the first minute to 300 or even 200. Mechanical vibration is by no means of recent origin, as it was used by Ling and also Georgi in the "trembling movements." Liedbeck and Granville both introduced a vibrator driven by mechanical power, and Ewer a percussor of similar type. More recently we have all heard of the Veedee and the quack Macara vibrator, worked very much like an egg-switch. Ewer's was worked by a foot pedal like a dentist's drill.

Electricity has made a great change in such apparatus, hand-power being entirely dispensed with. In 1898 Otto Billmaier invented a very excellent type of instrument, one of which we possess, rather worn out, and unfortunately have been unable to replace, as we consider it the best vibrator yet introduced. It consists of a hand-piece connected by means of a cable to an electric motor. The vibrations are produced by means of a revolving eccentric—a hammer in the hand-piece on which is a sliding adjustment which regulates the height of the strike of the hammer from zero to 1 centimetre.

No rheostat is said to be necessary in using this machine. The power may be derived from a 110 volt circuit—direct or alternating—or from a storage battery. The motor may be suspended from a wall or ceiling, or supported on a special stand with a heavy immobile base.

A pulsator vibrator is provided with the multostat or universal apparatus, and is quite effective. The vibratodes are usually two rubber balls and a round disc with a bevel.

The Barker vibrator is a very well known one, and is quite

FIG. 89.—VIBRATOR APPLICATORS.

BB, Bristle brush applicator for the head; 44, softest rubber with thin points; 54, soft rubber with thick points; 56, harder, stiffer rubber with thick points, principally for the head; same as 54, but smaller in diameter; same grade of rubber, as *R* is smaller and thinner; 70, soft, red sponge rubber for face and head, and other light and gentle uses; *A*, for spinal application, also for external rectum treatment; *O*, flat, soft rubber applicator; *T*, for nose and ear, and used on children to reach interna organs through external openings; *K*, flexible back, sold only to replace worn-out part of flexible back applicators; *E*, flat, hard rubber body applicator for deep local work; *I*, large aplicator with flexible back for deep and general work; *H*, large applicator with flexible back, excellent for deep and general work, also when quick reaction is desired; we specially recommend *H* as most generally efficient for body work; *J*, most severe applicator, with flexible back; *VW*, very soft and pliable applicator for rectal use; *U*, same applicator as *V*, but of stiffer rubber; *X*, hard rubber rectal dilator with flexible back for use after applicators *V* or *W*; *Y*, hard rubber rectal dilator with flexible back for use after applicator *X*; *Z*, hard rubber rectal dilator with flexible back for use after applicator *Y*; *M*, round hard rubber for deep local work.

effective, a great variety of vibratodes being provided with it. Smaller and less powerful, but effective for purely local affections, is the Victory. This is quite portable and inexpensive.

The Effect of Vibration.—This will vary with the amount of force used and the rapidity of the vibrations. It is used in a great variety of disorders—headache, earache, neuralgia, and neuritis. One of the most effectual ways of combating a sluggish liver is five to ten minutes' vibration over the hepatic region, which is equal to at least an hour's horse exercise. It is excellent where there is a tendency to jaundice and pale stools with dark-coloured urine.

In the various myalgias and muscular rheumatism relief of pain is quickly brought by vibration along with heat treatment.

CHAPTER II

MANIPULATIVE TREATMENT AND ZANDER EXERCISES

Manipulative Movements.

We employ these as a sequel to or combined with massage. Movements may be active or passive.

1. **Passive Movements.**—This is sometimes called a relaxed movement, the idea being that the patient should endeavour to attain the highest degree of relaxation while the masseur imitates the movements normally performed by the patient's own muscles. Many masseurs make the mistake of carrying out from the start too wide a range of movements. He should begin with minor movements, and gradually increase them. The patient's co-operation must be enlisted, and he must neither assist or resist the manœuvres which are carried out; he should, in short, be "as clay in the hands of the potter."

Complete relaxation is not easy of attainment. We know that in manipulating an injured joint to break down adhesions and the like the muscles unconsciously resist the movements made by the operator, and chloroform is sometimes needed, as it is in the reduction of dislocations.

We probably attain the highest degree of relaxation in sleep, but as we cannot put our patients to sleep for passive manipulation, and should quickly wake them if we did, the only means we have is to make them as comfortable as possible, getting them adjusted into attitudes of complete restfulness. If we disturb this, then the patient's muscles will act in one way or another, so that we must take precautions to support the part manipulated when it is moved from one position to another.

It is also vital for the manipulator to carry out the movement in just the same direction and on the same lines as the patient would if doing it of his free will.

Certain combinations of movement are best carried out at the same time. We flex the fingers along with extension of the wrist, and extend the fingers with flexion of the wrist. The wrist is extended with pronation of the forearm, and flexed with the forearm midway between pronation and supination.

Supination of the forearm is combined with flexion of the elbow, and pronation with its extension; flexion of the forearm is most easily performed if the elbow is pressed back at the same time.

Abduction of the arm is combined with flexion of the elbow, while during adduction the elbow should be extended.

As regards the lower extremity, flexion of the toes should be combined with flexion of the ankle, and extension of the toes with plantar flexion; this latter, again, calls for extension of the knee, though the knee be kept slightly flexed, even when the ankle movement is at its extremity. Dorsiflexion requires increasing flexion of the knee. This, again, must be combined with flexion of the hip, and extension of the knee with hip extension.

The hip is best adducted and abducted with the knee and ankle semiflexed, while rotation requires alternate flexion and extension of the knee, flexion accompanying that part of the movement when the hip is most flexed, and extension of the knee the part when the hip is most extended.

Movements of the metacarpals and metatarsals are important, as they are often affected with chronic rheumatic or slight rheumatoid trouble in people getting past middle life, which interferes with writing and weakens the grip, or may cause lameness when it is a question of the metatarsals.

The great objective in passive movements is to maintain suppleness and prevent the formation of contractures and adhesions, and to effect this painlessly. This can only be effected by the use of skill and caution.

Festina lente should be the motto, and if the range of movement is at first disappointingly small and almost

negligible, it will with care and perseverance increase to the satisfaction of patient and operator alike.

2. **Active Movements.**—Mennell divides these into—(1) Free; (2) Assistive; and (3) Resistive.

(1) *Free Movement.*—If a movement is performed against gravity, it is performed against resistance. Movements, on the other hand, of abduction and adduction with a weight and pulley apparatus are free, owing to the weight of the limb being counterpoised.

The division between free and assistive movements is a fine and almost arbitrary one, however.

Free movements of the fingers are best performed with the hand resting on its ulnar border, the forearm being held midway between pronation and supination. To perform free flexion and extension of the wrist the forearm should be supported in this position, with the hand hanging free.

In the same way we carry out free rotation. Free flexion and extension is best performed with the patient recumbent, the back of the arm and the elbow being fully supported and the hand moved up and down the chest.

As regards the lower extremity, free movements of the ankle and toes may be carried out with the leg hanging over a bench or couch.

Free movement of the hip or knee cannot be effected without some assistance, manual or mechanical.

Considerable assistance to the carrying out of free movement is afforded by the use of the whirlpool bath described on p. 110. In this the water affords a certain amount of support, and the warm water removes the element of stiffness in large degree.

(2) *Assistive Movements.*—Here in each movement there is a certain amount of manual assistance, which has the object of enabling the patient to do more than he otherwise could unaided, and so "get him on." It is in a measure educative.

A principle of the greatest importance that has to be borne in mind in work of this character is that, if one muscle contracts in order to move a joint, some other muscle or group of muscles must relax.

It is often necessary to combine passive movements with assistive movements; that is to say, while a patient may be sufficiently well to use one set of muscles in a limb, as regards other movements we have to give him such help as to render the movement passive. Later the patient may endeavour to imitate, and the assistive movement gradually takes the place of the passive one.

If a movement causes a tremor of coarse character in the muscle or muscles contracting, it should not be continued. The movement should be first carried out passively, and then the patient allowed to assist.

(3) *Resistive Exercises.*—These are of two kinds—eccentric and concentric. In the first the worker supplies the resistance and performs a movement, while the patient resists. In the latter the patient performs the movement, while the worker resists.

In recovery from paralysis care should be exercised in employing eccentric movements, and the stretching of muscular fibres must always be avoided.

Mechanotherapy, or Treatment by Mechanical Means.

The Zander machines have rather waned in popularity with a tendency to substitute manual manipulation for the power-driven Zander machines, with which occasionally unfortunate accidents occurred, with unfavourable results. The type of machine now employed is the Borderel Zander, or activo-passive. We shall deal below with twelve of the best-known and commonly used types of machine, as used in the Mechano-Therapeutic Department, at Harrogate.

1. **Circumduction of the Arm.**—Place the patient sideways against the fork on which the armpit must rest. The seat is raised or lowered until the fork touches the fold of the armpit. The patient grasps the movable handle with the arm fully extended, and turns the sector. The axle around which the movement is made is movable, so that it can take varying degrees of inclination.

2. **Active and Forced Rotation of the Arm.**—The patient sits down beside the apparatus and places the forearm on the wooden lever. He grasps the handle and leans the elbow

against the iron ledge attached to the fixed end of the lever. The patient should be careful to keep the arm vertical and prevent false movements of the body. The other arm should

FIG. 90.—CIRCUMDUCTION OF ARM.

FIG 91.—ROTATION OF ARM.

be fastened to the upright with a strap. The wooden scale is loaded with one or more flat weights, and the forearm gives slowly to the pull of the weights.

3. **Lowering of the Arms with Flexion of the Forearms.**—This exercise deals with the lowering of the upstretched arms by bending the forearm against the upper arm. Place the patient beneath the suspended handles, which must be on

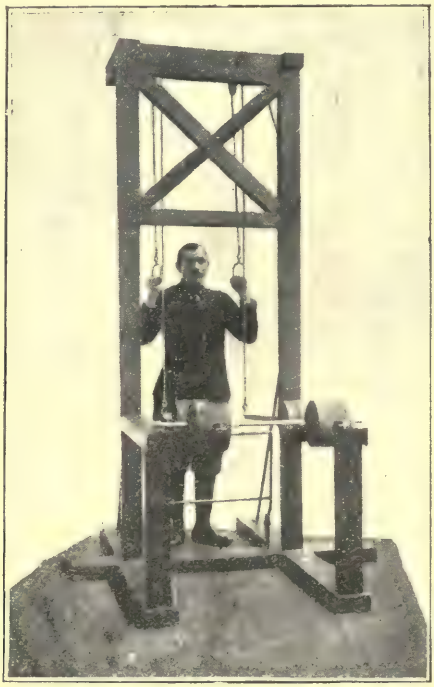


Fig. 92.

a level with the shoulders. He must grasp them, and give slowly to the action of the weights, which draw the arms upwards. Then he lowers his arms until his hands are on a level with his shoulders, and again yields to the pull of the weights.

4. **Flexion and Extension of the Wrists**—*Flexion.*—The wrist must be placed slanting upwards, with the long part of the lever below and the short above.

Flexion of the Left Hand.—The screw of the attachment must be fixed to the letters *F*, *G*.

Flexion of the Right Hand.—The screw of the attachment must be fixed to the letters *F*, *D*.

Extension.—The patient's wrists must be slanted vertically downwards. To carry out the active movements, place one weight at the end of the short part of the lever and the other

Fig. 93.

weight on the long part at a distance corresponding to the resistance required. To carry out the pendulum (swinging) movement, place both weights at the end of the long part of the lever.

5. **Flexion and Extension of the Forearm.**—The patient is placed beside the apparatus, and the arm to be exercised is fastened with the straps of the supports.

The elbow must rest in the axle of the lever. By means of planks placed beneath their feet patients who are below

the middle height can raise their elbows to the heights required.

The handle is grasped with the palms turned upwards. In the flexion movement the handle must be down, and the counterweight on the half of the double lever which is in front of the patient. In the extension movement the handle must be up, and the counterweight on the half of the double

Fig. 94.

lever which is behind the patient. In order to pass from flexion to extension it is enough to change the weights from one half to the other of the double lever. When it is a question of exercising a left arm after a right arm, or *vice versa*, the position of the hand lever on its post must be changed by passing the rundle provided with clutches. This manœuvre forces out the screw rings which hold back the lever, which turns 180 per cent. around its axis.

6. **Pronation and Supination of the Forearm (Active and Passivo-Active).**—The handle of the apparatus is placed in a horizontal position for the pronation, and in a vertical position for the supination. The double lever must in both cases be in a vertical position and the counterweights beneath. At the outset of movement of pronation the back of the hand is turned downwards with the thumb behind. At the outset of the movement of supination the back

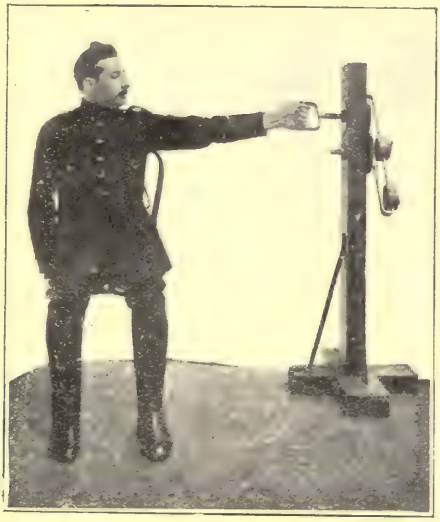


FIG. 95.

of the hand is turned forward with the thumb downwards. The arm must be held firmly outstretched. To carry out the active movement, one weight must be placed in the centre of the lever and the other at a distance from the centre which corresponds to the resistance which is required to be overcome.

The movements may have another purpose than that of exercising rotatory muscles of the arms. It may tend to produce suppleness by extension of the rotatory muscles of the tendons and ligaments of the arm. In this case a weight is placed at each end of the lever, and there is no need for concern after the position of the handle and the lever.

7. **Circumduction of the Hand.**—The patient should sit down on a chair beside the apparatus, and at a sufficient distance from it to allow the forearm (which is fixed by a strap to the table) to be kept in a straight line to the axis of the wheel. He should grasp the handle and perform a movement of circumduction with the hand.

The degree of movement can be increased or decreased by fastening the fixed end of the handle at a greater or less distance from the axis of the wheel.

Fig. 96.

8. **Flexion and Extension of the Fingers.**—This apparatus permits of the execution of active and passive extension and flexion movements of the fingers, and also of a pendulum (swinging) movement which constitutes something midway between active and passive movements.

The ends of the fingers are placed between two padded iron plates and the screws tightened. The patient grasps the upper part of the iron frame. The oscillatory movement forced on him causes the flexion and extension of the fingers.

To carry out the passive movement, the screw of the attachment of the lever is loosened. To carry out the pendulum movement, fix the weight to the end of the long part

of the lever and tighten the screw of the attachment to the required degree—that is, to the front which corresponds to the limit of the movement to which the patient can attain.

To carry out the active movement, shift the weight towards the centre of the lever and tighten the screw of attachment on the iron plate to the highest position of flexion or extension of the hand, the lever being vertical.

Fig. 97.

9. **Extension of the Thigh and Leg.**—This deals with a simultaneous extension of the articulation of the thigh and leg.

The patient should stand before the apparatus and place his hand on the wooden uprights. He must place the foot on the iron pedal, which is controlled close to the ground by a catch. On placing the foot on this pedal, the "Debrayage" is started and an upward movement results, to which the limb gradually yields.

To terminate the exercise, the catch must be applied to the arm of the lever and the pedal.

10. **Flexion of Leg and Thigh.**—This deals with the simultaneous flexion of the joints at the hip and the knee. The patient stands before the apparatus with both feet on the

FIG. 98.

FIG. 99.

same level. The foot to be exercised is placed on the pedal, and the patient should lean upon the lateral uprights and raise the foot.

11. **Flexion and Extension of the Knee.**—This deals with the bending of the leg at the knee-joint. Place the patient in the armchair and lower him until the knee-joint is level with the rotatory axis of the apparatus.

Flexion.—The leg to be exercised is placed on the padded carrier of the support. This cross-bar must rest a little above the heel. The thigh is fastened with straps to the seat.

Extension.—The leg to be exercised is placed behind the carried the cross-bar resting above the joint of the foot.

Fig. 100.

The little weight which is placed on the lever is meant to counterbalance the weight of the leg in the flexion movement. In order to fulfil this condition, it should be fixed to the end of the lever—letter *F*. In the extension movement it should be fixed to the letter *E* near the axis of rotation. Cases of ankylosis of the knee require forcible extension or flexion. To obtain forcible flexion the apparatus is placed in the extension position. To obtain forcible ex-

tension the apparatus is placed in the flexion position. Care is then needed to change the weights gradually and without jarring.

12. **Circumduction of the Foot.**—Place the foot in the iron stirrup and then fasten firmly with a strap, Circumduction is carried out by a series of movements of flexion and extension of the foot. The extent of the movements can be regulated at will by flexing the rod at a greater or lesser distance from the axis of the wheel on the iron sector. The handle placed on the wheel allows of the movement being carried out passively.

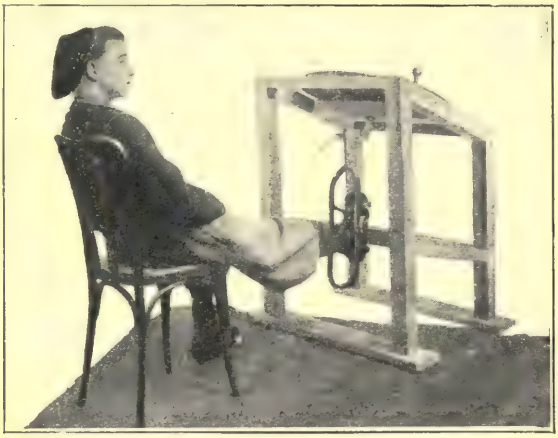


Fig. 101.

The great advantage of these machines is that the patient can use them for himself (active treatment), or it can be done for him by a skilled operator (passive movement).

The benefit derived is always enhanced by the subsequent use of bathing and douching in one form or another.

Good results have been obtained from these machines alone in a very great number of cases treated—injuries resultant from the war. Better and quicker results are obtained, however, by combining soaking the part affected in hot saline solution, following with massage and passive movements, and then finishing with the mechanical apparatus. The exercises are divided into *active*, the patient doing

the work himself; and *passive*, the work being done for him; also *duplicated*, the work partially done by the patient assisted or resisted by the operator. The Zander or Borderel apparatus lend themselves most admirably to the duplicated exercises, which, on the whole, are the most effectual.

FIG. 102.—MECHANOTHERAPY SECTION.

Zander exercises, which are carried out by a system of power-driven machines, are seldom useful and often dangerous, capable of doing much harm, though sometimes producing good results.

Other forms of exercise in which the movements are wholly active are—(1) Wall bars; (2) climbing pegs; (3) grip dumb-bells; (4) the Velotrab, or fixed cycle; and (5) the weight and pulley machine.

The Physiology of Muscular Exercise.

Apart from remedial muscular exercises, a knowledge of the changes taking place in the body during *muscular exertion* is of wide interest to everyone. It is, above all, important, however, that the physician who has to decide daily what amount of exercise his patients are fit for should

be familiar with the changes which are produced by muscular activity on the various organs of the body; and, most important, the effect on the cardiac and respiratory organs. Bainbridge defines muscular exercise as the highest expression of the activities of the body considered merely as a machine. Almost all the resources of the body are mobilized to bring about the greatest efficiency of the neuro-muscular system.

It is very remarkable to observe at any time the wonderful co-ordination of muscular movements and the immense capacity of the body to develop energy in a professional athlete or trained gymnast. The highest pitch of training is only attained by constant practice and the concentration for the time being of the nervous system and mentality of the individual on the actual muscular movements carried out. This is one of the most essential factors in physical training. Nevertheless, the actual energy for the carrying out of physical work is actually developed in the muscles themselves, and their power to transform potential into kinetic energy is the central fact of muscular exercise.

It is quite clear, however, that the processes taking place in the muscles themselves constitute only a fraction of the total activities of the body during exercise. Oxygen is always necessary for the restoration of the potential energy of any muscle; in its absence, mammalian muscle quickly loses its power of contraction. In ill-ventilated mines, for instance, coal-workers quickly become fatigued and their output falls off. It has further to be borne in mind that, since the energy of muscular work is ultimately obtained from the oxidation of food-stuffs, along with increased muscular energy, there is a rise in the intensity of their metabolic activity and oxygen consumption. Briefly, the oxygen consumption is an index of muscular activity during exercise.

Brisk muscular effort taxes the resources of the cardiac and respiratory systems equally with those of the muscles themselves, and, generally speaking, the heart reaches its limit of endurance sooner than the skeletal muscles. We know that in running for a train we usually get winded

before our leg muscles fail materially, though that soon follows. Elderly people get an early warning that the limit of their athletic capacity has been reached, and if they are wise they take it.

The effect of physical training is to bring about a perfect co-ordination between the circulatory and respiratory systems on the one hand, and the skeletal muscles on the other, so that a maximum amount of work is produced with a minimum of effort. Anything less means inefficiency. Competitive efforts between trained and untrained persons will quickly demonstrate the great importance of this fact. It is, however, quite remarkable how people even beyond middle life, not strangers to tobacco or alcohol, will, after a period of abstention and graduated effort, attain a high degree of efficiency and muscular "fitness."

In the trained athlete every muscle and organ works smoothly with perfect harmony of action, while with the less trained person there is greater sense of effort, clumsiness of movement, and notably more severe cardiac and respiratory distress.

In muscular exercise, therefore, there are three points to bear in mind: (1) The changes in the skeletal muscles leading to the output of energy; (2) the changes occurring in other parts of the body to provide the muscles with oxygen and food-stuffs for this purpose; and (3) the means by which these are interwoven and correlated to produce the whole fabric of muscular exercise.

The Relation to Food-Stuffs.—Usually protein foods do not serve as a source of energy during exercise, the energy being mainly derived from hydrocarbons or carbohydrates. When both are available, the skeletal muscles display a preference for carbohydrates. The net efficiency of the body machine varies from 20 to as high as 33 per cent. (Bainbridge).

The factors influencing mechanical efficiency are training, the speed of the work performed, and fatigue.

Oxygen Consumption.—To meet the demands of the tissues for oxygen during exercise, not only is a more rapid rate of circulation necessary, but there must be a close correlation between the pulmonary ventilation and the rate of the heart-beat. The circulation-rate around the body depends

primarily on the output of the heart, which varies from 3 to 5 litres per minute at rest to 20 litres or more during heavy work.

A large output calls for a corresponding increase in the diastolic filling of the heart. While exercise is being carried out the return of blood to the heart is increased, partly by the active muscles, which mechanically squeeze the blood out of their capillaries and veins into the greater veins, and partly by the respiratory movements, especially those of the diaphragm.

The heart can increase its output per minute either by larger output per beat or by acceleration of the pulse-rate. The output of the heart per beat depends on "the law of the heart" that the force with which the heart muscle contracts depends on, or varies directly with, the volume of the heart at the end of diastole.

Physiological dilatation of the heart is known to occur during active exercise, with the result that the heart is unable to increase its output per beat in response to a large venous inflow.

The physiological limit is reached when the heart at the end of diastole fills the pericardial sac.

The influence of the acceleration of the pulse on the output of the heart per minute is determined by the rate at which the heart fills during diastole. If the venous flow is small, the heart fills fairly uniformly, so that little change in the output occurs. If, however, the venous inflow is rapid, the heart fills almost completely during diastole, and the output per minute increases almost proportionately with the acceleration of the pulse.

A fall of pressure in the great veins occurs from blood being transferred rapidly from the venous to the arterial system.

The output of the heart per minute depends on the contractile power of its fibres and its rate of beat, and the rate of the pulse during exercise and its acceleration partly on cortical impulses to the vagus and accelerator centre, and partly to the influence of the rise of temperature of the body on the vagus centre, which also is reduced in tone from the reflex effect of great diastolic distension of the heart.

There is always a close connection between the frequency of the pulse and the intensity of muscular work. It must be concluded that impulses from the cerebral cortex to the skeletal muscles run parallel with others to the vagus and accelerator centres.

The maximal pulse-rate of about 160 during exercise is much the same in different individuals, but *the maximum output of the heart per minute varies, and depends on the capacity of the heart in different subjects to increase its output per beat*—in short, on its contractile power and the tone of the muscle fibres.

The mechanical efficiency of the heart varies from 20 to 30 per cent., and is higher than that of the body as a whole; it quickly diminishes, however, if the pulse accelerates during exercise without a proportional increase in the output of the heart per minute. The immediate effect of this larger output is, of course, to increase the blood-supply to the active skeletal muscles, the flow of blood in which may increase from six to eight times what it was during rest.

The blood-pressure rises in the arteries during exercise as a result of the increased cardiac output, constriction of the splanchnic vessels, and dilatation of the vessels of the muscles and skin. Constriction of the splanchnic vessels is due mainly to central impulses to the vasomotor centre. It is possible that the centre is also stimulated by the greater H-ion concentration of the blood during exercise.

As regards oxygen consumption, the active muscles during severe exercise take up from each fraction of blood flowing through them twice as much oxygen as during rest; and as the circulation-rate is greatly increased, the actual oxygen consumption is, of course, enormously enhanced. Oxygen reaches the tissues from the blood mainly by diffusion, and once the oxygen reaches them it quickly enters into chemical combination, so that the oxygen tension in the tissues is nil. The rate of diffusion varies with the oxygen tension in the blood-plasma, which is again dependent on the rate of dissociation of the oxyhæmoglobin in the capillaries. During exercise this is much quickened, from the increased H-ion concentration of the blood.

Exercise calls for far more work than is necessary

when the body is at rest, and there is much greater demand for oxygen; the ability of the heart to meet the calls on it will depend largely on its intrinsic blood-supply; the flow of blood through the coronary arteries may be as much as six times greater than it is at rest (Bainbridge). Rise in blood-pressure in the arteries and dilatation of the coronaries is essential to meet the needs of the human heart during exercise.

Taking a broader view, however, we have to remember that the activities of the skeletal muscles, the nervous system, the heart, and lungs, have to be co-ordinated and linked together, so that the body during exercise may act as a physiological unit. The activity of the skeletal muscles is correlated with the rest of the body in three ways: (1) The greater mechanical activity of the muscles in returning blood more rapidly to the heart; (2) the increased H-ion concentration of the blood and increased flow through the muscles; and (3) the greater outflow of impulses from the higher centres to the medullary centres.

Under the stress of excitement or competition a man may be able to carry out much greater muscular efforts than he is ordinarily capable of, and the fuller mobilization of the resources of the body under these conditions is only possible if the greater muscular effort is accompanied by corresponding increase of the blood-supply to the muscles, heart, and brain, with efficiency of the circulatory and respiratory adjustments.

A man's maximum working capacity is ultimately determined, not by the functional capacity of his skeletal muscles, but by the supply of oxygen to muscles, heart, and brain. The limit of his exertions is reached when the output of the heart fails to respond to the demand of the tissues for oxygen.

It is axiomatic that anything like the maximum capacity or degree of efficiency can only be obtained by training. Regular and progressive exercise is the essential feature of such training; the food taken, while of moment, is entirely a subsidiary matter. Proper training develops the skeletal muscles and the heart, which in a healthy man progress *pari passu*. As the heart acquires increased contractile power its output per beat is larger, so that the pulse-rate is usually

slower in the trained man even when at rest than in the untrained. With the same amount of exercise in the trained and untrained, this again holds true. It is partly due to the greater output of the trained heart, but also to the greater coefficient of utilization and oxygen-carrying power in the trained man; less output per minute is thus called for. Training also brings about a better co-ordination of movement and improves the mechanical efficiency of the body, so that work is performed with the utmost economy of effort.

Trained men also get what is known in sporting circles as their "second wind." In this state the tension of CO_2 in the pulmonary alveoli falls, and there is a decrease in the pulmonary ventilation; there may be at the time a diminution in the H-ion concentration in the blood, as a result of the greater mechanical efficiency of the body, an improved blood-supply to the body muscles, and the free exchange of acid and base radicles between the blood and the tissues. These are probably some of the causes contributory to "second wind."

Fatigue.—Fatigue after exertion is characterized by a diminished capacity for the performance of work, accompanied by certain subjective sensations. The sensation of fatigue, however, does not correspond necessarily with the actual fatigue of the individual when this is measured by his capacity for work. Fatigue may originate entirely in the central nervous system, or partly in the nervous system and partly in the muscles. The latter is comparatively rare, while ordinary industrial fatigue, which we all more or less feel at the end of the day, is of the former type. There is nothing to show that the products of muscular activity bring it about; it is rather due to an expenditure of nervous energy which renders the subject unequal to further sustained muscular or even mental effort.

Good Results of Exercise.—Regular exercise has a notable effect on the whole life of the individual. It promotes and in most people is essential to the maintenance of good health —if by that we mean the highest efficiency of mind and body.

The more active blood and lymph flow favours complete

combustion of metabolic products and the removal of waste material, nutrition being thus promoted. The speeding-up of the metabolic activity of the body which is the characteristic feature of exercise involves the more rapid utilization of reserve nutritive material, and probably also the more complete oxidation of these materials within the cells. Cells are thus not clogged by substances awaiting combustion, or by waste products incapable of absorption, but awaiting removal.

During exercise the additional energy provided by the more active chemistry of the tissues is expended as work or heat; but the exercise finished, the tissue metabolism remains active for a time, leading to repair and building-up of the tissues. This demonstrates the importance of regular games and field sports for the young, so that the whole body may develop along with the mind, and shows also that the incessant activity of the healthy child is as necessary for its normal growth and health as it is sometimes trying to adults.

Exercise has a most important influence in keeping the digestive and nervous systems healthy. Sedentary workers are prone to suffer from dyspepsia, and the cobbler often combines it with Socialism and discontent, it is said. Regular exercise improves the appetite, promotes the flow of digestive juices and the passage of food along the digestive tract by mere mechanical action alone. But, furthermore, it has a very valuable indirect psychic effect on the individual by diverting the ordinary activities of the mind; it reacts beneficially on the mental attitude and physical well-being; this aspect of it is very important in later life.

CHAPTER III

MEDICAL GYMNASTICS

Medical gymnastics consist in the use of systematically arranged exercises, with the object of securing the restoration or preservation of healthy functional activity.

If we do not use our muscles or organs they waste or atrophy, and the continuous adjustment of internal relations to external relations which constitutes health is interrupted. Wasting of muscular power may be due purely to an idle life and neglect of exercise and games, which, it must be admitted, is unusual in this country, as the natural Britisher is fond of all games and sport, and possesses, as he has shown in the late war, a very high-class average of physical strength and endurance quite apart from any mental equipment. There is no truer axiom than *Mens sana in corpore sano.* Among the upper and middle classes, indeed, quite aside from sport, there has been for the last twenty years quite a craze for exercises. We owe something to Mr. Eustace Miles for starting the habit or craze. Eugene Sandow exploited the movement for commercial ends; then came Müller and exercisers of all sorts and descriptions, chiefly of the weight and pulley type. One of the best was Dowd's, which the author has had and used periodically for upwards of twenty years. But no special apparatus is in truth required. Many most excellent exercises can be carried out on a square of carpet without any mechanical aid.

As regards the conditions which give rise to the necessity for physical training and treatment, apart from neglect of sport and games, the occasion may be the constant necessity for study and indoor work, or illness or injury necessitating confinement to bed.

Beginning with massage to get the patient on his feet literally, we can proceed with systematic exercises which will confirm and increase the good the massage has done. It may be feared that exercise systems have lent themselves to abuse and tended to a sort of valetudinarianism, and have actually done harm through too *heavy* exercises being taken up by people advanced in life, making too great a demand on their cardiac musculature; but how quickly young adults develop and improve with physical drill has been proved to demonstration in tens of thousands of cases when Kitchener's army was being made ready.

If we are asked how the individual benefits by exercises, our reply is, By increased tissue change. Every movement eats up so much pabulum, which has to be replaced if waste is not to occur. Waste matter finds its way from the muscle into the veins, thence to the lungs, and there becomes oxidized. Given adequate nutrition and a vigorous circulation, repair will keep ahead of the waste so caused. CO_2 is being constantly exhaled and oxygen inhaled, to be absorbed in the muscles; and when engaged in active exercise we know by our quickened respirations and quicker pulse this process is much increased. We all know in the vigorous exercise of boxing how soon we may get winded, if not in training, and here the tissue regeneration lags behind for the moment, and a pause must be made. Ample oxygen and good sound blood to carry it are necessary; if we are anæmic or box in a stuffy room, then the exhaustion occurs much sooner. A muscle in contracting compresses a vein in or near itself, promoting the flow of blood to the heart; every repetition of the movements increases the flow towards the heart, and it is the scientific application of this fact to medical gymnastics that forms the basis of the Schott and other heart exercises.

When a muscular contraction has occurred, the veins contain less than their full complement of blood and exercise a degree of suction on the capillaries, the propelling effect of the arterial contraction increasing this, with a resultant accelerated flow. While contracting, the vessels are alternately shortened and lengthened: when lengthened, they of course hold more blood than in the reverse condition. The

more muscles engaged in contraction, the greater the help to the circulation—a regular and larger supply of blood is propelled towards the heart by what is called the *vis a tergo*. When this cannot be effected by exercise, as in cases of serious illness, debility, and injury, we employ what are known as passive movements (*vide infra*).

Movement, therefore, ultimately results in the carrying of increased supplies of oxidized blood to the part or parts exercised. Concomitantly with increased cardiac activity the lungs have to work harder, so to speak, and allow of the fullest inspiration and expiration getting rid of waste products and renewing the oxygen in the blood. To secure this the whole complicated system of joints, ribs, and muscles making up the thoracic wall require exercise, the thoracic cavity itself being distended and contracted to the highest degree. A chest that is flexible is of the utmost importance; every healthy child has this practically, and every effort should be made to retain and develop it. Watching a child who is stripped, one is at once struck with the easy flexible way the thorax expands and contracts, either when deep breaths are taken intentionally or to relieve the brief dyspnœa occasioned by a short run. It is our object in the giving of exercises to retain this free play as long as possible on into adult life.

With the back erect, neck kept straight, head erect, chin drawn in, and the chest generally elevated, inspirations are plainly deep in character, the oxidation of venous blood is more thorough, and the circulation generally quickened.

Having dealt with the immediate and most necessary supply of oxygen, we now have to consider the increased demand for food of one sort or another occasioned by exercise. If a great deal of active exercise is taken, a diet in which the starchy element is cut down and the nitrogenous increased will be found best. Beef, mutton, eggs, with a few green vegetables and dry toast, form the staple portion of the training diet of a Cambridge or Oxford undergraduate. Beef and beer play an equally important part in the pabulum of a hard-working navvy or iron-founder.

If an athlete is put through heavy exercises and underfed, he will get stale, just as, if the training is overdone with

sufficient food, the same condition will arise. He loses his ambition and his vitality generally declines; he sleeps badly, wakes tired, and loses interest in his surroundings. His blood-pressure falls, and the pulse-rate, which should not increase more than eight in changing from the sitting to the standing position, increases by as much as twenty or more.

Gradual decline in weight occurs, and only rest—perhaps complete rest, with only massage and passive exercise—can restore him.

It cannot be absolutely laid down that animal diet is essential to fitness, but it appears to be largely so with Western European races. On the other hand, both Chinese and Japanese thrive on a purely rice and vegetable diet, and the latter more particularly engage in sports of the most arduous kind, and are adepts at the art of war and highly virile, as they fully demonstrated in their war with Russia in 1904 and 1905.

A good development of the abdominal muscles usually goes with a good digestion, and exercises tending to strengthen these usually go to promote good health, ample secretion of digestive juices, and the condition generally called "eupepsia." The abdominal organs, almost without exception, can be powerfully influenced either by exercise or manipulations and vibration.

Vibration over the liver, it may be said, will do as much in five minutes to promote the flow of bile as forty minutes on horseback, and a few minutes' gentle scratching on the skin just below the left costal margin will quickly open the pylorus and cause emptying of the stomach towards the later stages of digestion. Kidney and liver activity are also promoted by trunk flexions and rollings. General abdominal massage and the use of flexions of the trunk and of the limbs on the trunk powerfully combat constipation.

The general effect of gymnastics and athletic training is to put the various body systems in a condition of equipoise, minimizing the fluctuation from the normal in every case. The comparatively slight increase in pulse and respiration rate of an athlete in training after a four-mile scamper is surprising to the city man, who gets puffed running fifty yards to catch his train to the suburbs.

Further, broadly speaking, men who are athletically trained and accustomed to hard out-of-door work seldom get troubled with nerves, though we must confess that on a deviation from the normal a very healthy man sometimes does show an overadequate display of concern! It is not suggested that mental training can be disregarded, but those men who become useful citizens, Members of Parliament or party leaders, have often rowed in their college eight and neglected no form of sport, and compare favourably, when all is said and done, with the dyspeptic Carlyle, who was declared by his own mother to be "ill to live with," or the vitriolic Voltaire.

Exclusive devotion to physical training merely produces brute force, sometimes associated with lack of control and initiative, but really scientifically directed gymnastics tend to preserve health through the whole period of manhood, combating abnormal developments, and fitting the whole organism to carry on the functions of life to the best advantage.

There is a certain moral tonic even in what is termed "a good carriage" to the person himself, and it helps to constitute what we know as "presence"—a very helpful possession in the struggle of life.

THE BRUCE-SUTHERLAND SYSTEM.

CLASSIFICATION OF EXERCISES.

Group I. Shoulders, Chest, and Lungs.	Group II. Spinal Region.	Group III. Waist.	Group IV. Lower Trunk and Leg.	Group V. Shoulders, Neck, and Arms.	Group VI. For Children.	Group VII. For Persons over Fifty.	Group VIII. For Stout Persons out of Condition.
No. 1	No. 3	No. 5	No. 5	No. 1	No. 1	No. 3	No. 5
,, 2	,, 8	,, 6	,, 7	,, 4	,, 2	,, 5	,, 9
,, 4	,, 9	,, 10	,, 8	,, 5	,, 5	,, 8*	,, 11
,, 5	,, 11	,, 11	,, 11	,, 10	,, 6	,, 10	,, 13†
,, 6	,, 12	,, 13	,, 13	,, 11	,, 12	,, 14	,, 15
,, 12	,, 13	,, 15	,, 14	,, 12	,, 21	,, 15	,, 18
,, 21	,, 15	,, 16	,, 15	,, 19	,, 25	,, 17	,, 21
,, 24	,, 16	,, 18	,, 16	,, 21	,, 28	,, 22	,, 22
,, 25	,, 20	,, 20	,, 17	,, 23	,, 30	,, 25	,, 25
,, 28	,, 22	,, 21	,, 18	,, 24		,, 26	,, 26
,, 30	,, 23	,, 22	,, 20	,, 25		,, 28	,, 27
	,, 25	,, 23	,, 23	,, 28		,, 30	
	,, 26	,, 25	,, 25	,, 29			
	,, 30	,, 26	,, 26	,, 30			
		,, 27					

* With knee bent.

† Movement only half-way down, ten times.

The Bruce-Sutherland System.

FIG. 103, NO. 1.—CHEST EXERCISE—INHALING DEEPLY, HANDS AT CHEST, EXTEND ARMS.

Position.—Stand erect with head well thrown back, feet together, and elbows raised in a line with the chest. The arms being bent, the hands will be in front of the chest, palms downwards, and thumbs touching the body.

Action.—The upper trunk muscles are used. While inhaling deeply, open out the arms firmly, describing a half-circle with the hands until they are in a perfect line with the shoulders and as far apart as possible; that is to say, you must stretch the shoulders outwards. At the same time, throw the weight of the body forward, rising on the toes, the lungs being thoroughly inflated. In that position pause slightly, then relax, falling back on the heels; exhale naturally without forcing, and bring the hands back to the chest again.

This extremely beneficial exercise should be repeated ten times for a beginning, and should always be performed with a free swinging motion, never in a jerky manner.

FIG. 104, NO. 2.—UPPER TRUNK AND LUNG EXERCISE—STEPPING OUT, ARMS RAISED ABOVE HEAD.

Position.—This exercise is designed to strengthen the chest and back. Stand erect with the arms down in front of the body, hands touching the legs. Keep the head well back, lips closed, feet together, shoulders braced well backwards.

Action.—With the right foot step outwards on the toes only, keeping the heels well off the ground, and at the same time raise the hands high above the head, making the muscles rigid, so that they may act as a lever upon the chest. Inhale deeply through the nostrils, and, looking slightly upwards and bending the back, make a momentary pause. Then go back to the starting position, at the same time exhaling and bringing the arms firmly down again to the front. This exercise may be performed for a beginning ten times, stepping out with each foot alternately.

NOTE.—Keep the heels well off the ground, as much spring is thus gained and the spinal column will be brought into play to a greater extent when stepping out.

FIG. 105, NO. 3.—SIDE, SHOULDER, AND BACK EXERCISE—SIDE SWAYING, ARM RAISED OVER HEAD.

This exercise is designed for improving the carriage and strengthening the spine.

Position.—Open out the feet, hands resting on the waist and body well thrown back.

Action.—Inhale deeply, raising the right arm outward and upward until the hand is stretched over the head. At the same time bend the body (side bending) over to the left, taking care not to incline the frame forward, as this would cause a relaxation of the pressure on the back muscles. Having brought the right arm over the head to the left as far as possible, make a momentary pause, exhaling, then bring the arm down again, hand to the waist, raising the body to the starting position. The moderate swaying motion has a most beneficial effect on the internal organs, particularly helpful to constipated subjects.

This exercise is sometimes performed with the feet together, but the sideways movement is then to some extent restricted. Repeat ten times, raising the right and the left arm alternately.

FIG. 106. NO. 4.—STRIKING-OUT MOVEMENT—EXERCISE FOR SHOULDERS, BACK, AND CHEST, TOGETHER WITH LEG AND ARM MUSCLES.

Position.—Bring both hands to chest, with elbows close to sides, feet together, and shoulders back.

Action.—Step out with the left foot and strike out with the right arm, forcing it straight out in front with hand closed and muscles of the arm tense. Do not lower the hand as the body goes slightly downwards on forward motion. The front leg should be bent, with the heel raised slightly off the ground, the rear leg perfectly straight. Having struck out to the fullest extent, draw the hand firmly back to the chest again, at the same time stepping back to the starting position, relying on the ball of the foot for the spring back. Repeat this movement with the right leg and left arm. Repeat it ten times in all, starting with the left and right foot alternately.

NOTE.—It is naturally easier to strike out with foot and hand corresponding—left foot and left hand or right foot and right hand—but the beneficial effect is not so great.

FIG. 107. NO. 5.—WINDMILL MOVEMENT.

This exercise brings into play practically every muscle in the body, and develops the chest and lungs.

Position.—Left hand at waist, the other at the side, frame erect, and head thrown back.

Action.—Bend down until the right hand touches the ground; then raise the hand in circular movement above the head, rising on toes and inhaling; then bring the arm down vigorously to the rear. Keep the arm straight, the hand closed, and the muscles firm. Inhale on the upward movement, and exhale on the downward. Follow the movement with the eyes; thus, as you bring down the arm to the rear you will turn the head in that direction. The arm not in use will remain at the waist, elbow to the rear, and should on no account hang limply at the side. When beginning the exercise, if you are not quite able to reach the ground, go down as far as you can comfortably do so, but on no account stretch the muscles unduly. Repeat ten times with each arm alternately.

FIG. 108. NO. 6.—DEEP-BREATHING AND CHEST-EXPANDING EXERCISE—ARMS EXTENDED IN FRONT.

This is a simple yet valuable exercise for the muscles of the chest.

Position.—Stretch the arms out firmly in front of the body in a line with the shoulders, hands touching, fingers closed, shoulders kept well back.

Action.—Open the arms well out until they are parallel with the shoulders, at the same time inclining the body forward in order that the chest may have greater expansion, and rising slightly off the heels. Breathe in deeply, with the chin raised; make a momentary pause, keeping the lungs inflated; then slowly bring the arms to the front again without lowering until the hands meet, breathing naturally and falling back on the heels. The muscles of the arm should remain tense while this exercise is being performed, and the movement should not be performed too quickly.

FIG. 109, NO. 7.—EXERCISE FOR THE FOOT AND LEG MUSCLES.

This exercise is designed for the strengthening of the spring of the foot and improving the calf muscles, thus developing the walking powers.

Position.—Stand erect, hands at waist, feet together.

Action.—Rise high on the toes, raising the hands to the chest in order to put tension upon the muscles of the body; throw the shoulders well back while yet remaining upright, in order to preserve the balance; the muscles must be tense. The forearm and wrist muscles may also be exercised in this movement by closing the hands tightly on the upward movement, and opening them out, each finger apart, on the downward. This leg exercise will be found invaluable for remedying any weakness in the instep. Repeat twenty times for a beginning.

FIG. 110, NO. 8.—LEG-RAISING MOVEMENT.

This leg-raising movement is one of the most powerful exercises known for building up the lower trunk.

Position.—Stand erect, with the hands at the waist.

Action.—Bend the body forward, at the same time raising one leg upward as far as possible; then bring the body firmly backward, at the same time bringing the leg smartly downward. Notice the action here is twofold—the raising of the lower limb to the fullest extent and the bending forwards of the upper portion of the frame. This has the effect of preserving the balance, and at the same time contracting the abdominal parts and extending the spinal region of the frame; a curve forward is formed when the body is thrown forward and the limb upward, and a curve in the opposite direction when the leg is lowered and the body thrown backwards. The average person should with practice so improve his joint action that he will eventually kick his own height. Repeat this ten times, using each leg alternately.

FIG. 111, NO. 9.—SIDE-BENDING EXERCISE—ARMS SWINGING ABOVE HEAD.

This powerful side-bending movement brings into play and exercises every part of the body.

Position.—Stand erect, with the arms extended in line with the shoulders, and feet well apart, chest out, and lungs inflated.

Action.—Bend over the body to the left, the right hand describing a circle over the head and going down to the left foot by much the same action as would be required in bowling at cricket. Take care that the arms are kept in a direct line with the shoulders, so that when the right arm goes down to the left foot the left arm will point upwards, having completed half a circle up the back, which, of course, it is bound to do if the arms are kept parallel with the shoulders all the time. As you rise up again do not cut corners by raising the hand from the foot to the starting position, but bring the right hand up the left side, then over the head to the starting position again. Repeat with the left arm to the right side. Repeat ten times for a beginning, inhaling on the upward and exhaling on the downward movement.

FIG. 112, NO. 10.—CHEST, BACK, AND TRICEPS EXERCISE—STEPPING OUT, THROWING ARMS TO REAR.

Position.—Stand erect with the shoulders back, elbows close to the sides, and hands at the chest, palms turned outwards.

Action.—Step out briskly with the right foot, and at the same time throw the body forward, but keep the back perfectly straight and the head thrown back, so that the chest may be opened out and the breathing may not be restricted. At the same time, straighten the arms downwards smartly and swing them backwards, hands clenched and knuckles outward, keeping the arms well to the sides. Put full pressure on the muscles of the arms, especially the triceps muscles at the back of the upper arm. When stepping out, keep the whole weight of the body on the toes. As you spring back into an upright position bring the hands back to the chest, keeping an equal tension on the forward movement and on the return. If not in good physical condition at the beginning, do not bend forward too far. Repeat this exercise ten times, stepping out with the right and left foot alternately.

FIG. 113, NO. 11.—SIDE-BENDING EXERCISE—HANDS TO KNEE AND ARMPIT.

This exercise is specially designed for strengthening the spine, making the frame lithe, and building up the waist-line. It also brings into play the shoulder muscles and the side and groin muscles, tending to reduce superfluous flesh.

Position.—Body erect, feet well apart, arms at the sides, hands turned in and close in to legs, head erect, leaning back a little.

Action.—Bring the right hand up along the side, rubbing the surface of the body closely on the way up, until it rests curled under the right armpit. At the same time the body is raised on the right side and bent over to the left. As the right hand is drawn upward, the left hand should glide downward until it touches the knee on the outside. Then reverse the movement until the right hand goes down to the right knee, the left hand going up to the left armpit. On no account should the body be allowed to bend forwards. This exercise causes a swaying to-and-fro motion. Repeat ten times.

FIG. 114, NO. 12.—CHEST, SHOULDER, BACK, AND ARM EXERCISE —ARMS RAISED ALTERNATELY ABOVE HEAD.

Position.—Hands clenched at the chest, head thrown back, body inclined backward, elbows to sides, and feet apart to give a better swing to the body.

Action.—Stretch each arm alternately high above the head, the chin being raised and the gaze also directed upwards. When the one hand is extended as high as possible, the other should be stationary at the chest. A steady pressure should be applied upon the muscles, and the movement performed without any jerky action such as might easily slip into this exercise. On the downward movement of the arms the biceps should be kept tense and firm, and the elbow should be pressed close to the side. Breathe regularly, as the chest remains mobile during the exercise. This exercise is frequently given with the heels together, but if the feet are opened a better swing is obtained on the spinal muscles. Repeat the movement ten times.

FIG. 115, NO. 13.—BODY-BENDING EXERCISE.

This exercise is designed for strengthening and bringing into healthy condition the abdominal parts. The movement is excellent for loosening the spinal muscles and joints.

Position.—Bend the frame well back with the arms extended above the head, hands open, palms to the front, and thumbs touching. The eyes should be turned in the direction of the hands, the chin raised, and the feet firmly placed on the ground slightly apart.

Action.—A good inhalation having been taken with the chest thrown well out, bend the body slowly forward, keeping it in line with the arms as much as possible, until the fingers touch the toes. Provided the joints are loose enough, the palms may even be placed on the floor. As there is compression on the abdomen and chest, it is advisable to expel all the air from the lungs during the downward motion. As the body is being raised up to the starting position, inhale deeply, keeping the chin clear of the chest, in order that there may be perfect freedom in breathing. This exercise should be performed very gradually, but as the frame becomes more supple it can be performed more vigorously. Ten times is sufficient for a beginning.

FIG. 116, NO. 14.—REAR-KICKING MOVEMENT.

This exercise is exceedingly valuable for loosening the leg muscles and giving the hip and leg joints, as well as those of the lumbar region, greater freedom of movement and increased elasticity. It will, moreover, prove beneficial to runners and others who have a tendency to cramp or stiffness in the legs.

Position.—Stand erect with hand at the waist, elbows to the rear, and tighten all the muscles from the hips downwards.

Action.—Bend the right knee, raising the foot upwards and keeping it close under the body. Bend the body forward; at the same time shoot out the foot to the rear, as indicated by the arrow in Fig. 116, until the leg is perfectly straight. This must be performed in one continuous movement, otherwise you will find it extremely difficult to keep your balance. Now bring the foot down to the ground again and repeat with the other limb. Repeat ten times for a beginning. This exercise should be performed vigorously, but not too quickly.

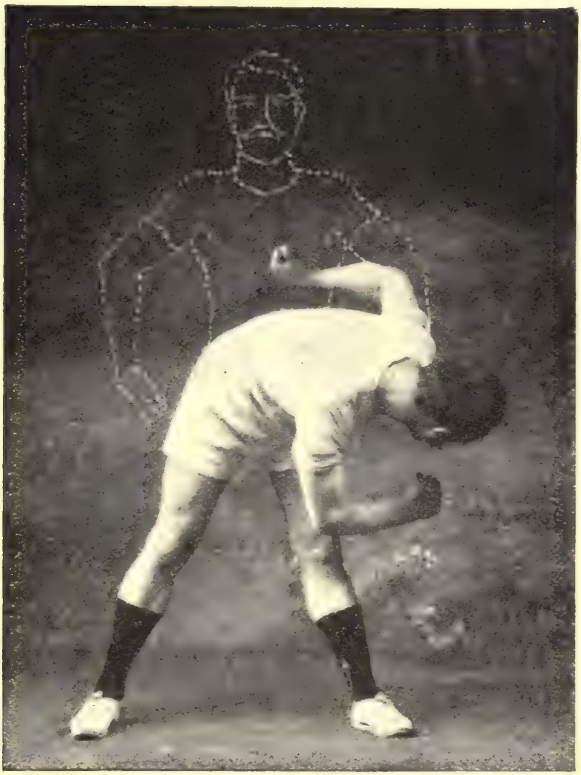


FIG. 117, NO. 15.—TRUNK-SWINGING MOVEMENT—TURNING TO REAR.

As a gentle movement, tending to improve the support afforded to internal organs, this is one of the very best exercises.

Position.—Stand erect, feet well apart, arms slightly bent, with the arm muscles made rigid, so that the arms may act as a lever pulling around the body.

Action.—Swing the body down to the left, bring the right arm across to the left, twisting the trunk round in the same direction as far as possible, and looking to the rear. You will find it very difficult to perform this exercise to your satisfaction. The body is rarely, if ever, required to swing into this peculiar position, and therefore it is difficult to carry it out gracefully at first, but with a little practice great improvement will be noticed. After the body has been pressed down, make a slight pause, and then rise straight up again, inhaling. Repeat, going down again in the opposite direction. Repeat ten times, bending to the right and the left alternately.

FIG. 118, NO. 16.—FORWARD-BENDING EXERCISE—HANDS BEHIND BACK.

This exercise has a fine bracing effect on the whole body framework, strengthening the spinal column and improving the carriage generally.

Position.—Stand erect, arms straight out behind, with hands clasped, palms outward, feet somewhat apart, firmly placed upon the ground, and head thrown well back.

Action.—After the lungs have been filled and shoulders thrown back, bend the body firmly forward, keeping the spine straight and the arms rigid. Exhale while going down. Do not bend the legs as the weight of the body goes forward, and be sure that your arms are raised as far up the back as possible until they assume a perpendicular position. Raise the frame up again, inhaling slowly as you rise, and, drawing the head well back, throw out the chest; make a pause, then go down again, repeating the movements. Repeat ten times.

FIG. 119, NO. 17.—KNEE-BENDING EXERCISE.

This exercise is most effective in making the joints of the lower extremity loose and free, and imparts a fine springing step.

Position.—Stand with the body inclining forward slightly, back straight, without the slightest indication of stooping, but rather the reverse, with chest thrown out and hands at waist. For those advanced in years or whose lower limbs are weak and muscles inclined to be stiff, it is advisable to keep the arms outstretched in line with the shoulders in order to preserve the balance and prevent toppling over. Such persons should not attempt to go too far down.

Action.—Rise on the toes, then sink gently down to the heels, keeping the knees well apart and maintaining pressure on the leg muscles, sustained until the knees can bend no further. Rise again slowly, remaining poised on the toes throughout the performance of the exercise. This movement is of great value for those who require to use their lower extremities at all strenuously, and with athletes shows surprising results. Repeat slowly and steadily ten times.

FIG. 120, NO. 18.—SIDE-BENDING EXERCISE—ARMS OUTSTRETCHED.

This exercise tends to reduce the body circumference at the waist-line in subjects who tend to accumulate superfluous fat over the abdomen. It strengthens the muscles of the groin and back and the lateral muscular wall of the abdomen.

Position.—Stand erect, arms tensely extended in a line with the shoulders, and feet apart.

Action.—Keeping the legs perfectly steady, bend down to the side and touch the floor with the left hand, the right arm being extended upwards and backwards in a line parallel with the left, so as to keep a steady and equal pressure on both sides of the shoulders. The proper time to exhale is when the body is down. Then rise to an upright position, taking care that both the downward and upward motion shall be a side-bending and not a front-bending movement. Perform the exercise ten times, bearing in mind that if your joints are not so flexible as that of the gymnast in Fig. 120, you will probably attain an equal degree of expertness with time and perseverance.

FIG 121, NO. 19.—NECK EXERCISE.

This movement will develop the muscles of the neck, filling the hollows of the throat and giving the whole a splendid contour.

Position.—Stand firmly in an attitude of looking upwards, with the head thrown well back and the feet placed well apart.

Action.—Bring the chin slowly forward until it rests firmly on the chest. Then, keeping the chin down, turn the head well round into the attitude of looking over the shoulder, still having the side of the head well forward. Then allow the chin to sink down again and turn the head in the opposite direction. Great care should be taken to follow the instructions thoroughly, so that the utmost benefit may be derived. It is not sufficient merely to swing the head round and look over the shoulder at each turn. You must not forget to keep your head well forward at the same time. The breathing should be regular, but not too deep, during these somewhat restricted movements. Repeat twenty times, turning to the right and the left alternately.

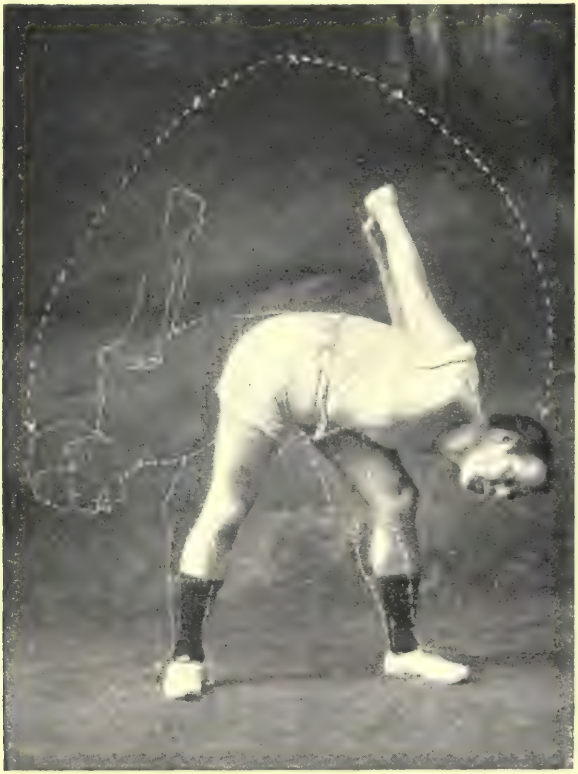


FIG. 122, NO. 20. SIDE-SWINGING EXERCISE—HANDS BEHIND BACK.

This excellent exercise develops a strong, lithe figure, and is specially effective in strengthening the spinal column in the lumbar region. It also tends to brace up the internal organs.

Position.—Chest out, shoulders back, and head thrown backwards. Clasp hands behind the back, palms outwards and feet opened out.

Action.—Throw the weight backwards, and from that position bend the body completely over to the right side, taking care that in so doing the weight of the body is not thrown forward. Endeavour as far as possible to bring the shoulder close to the leg, exhaling as you go down; then pause for a moment and rise up again, inhaling. Keep the arms perfectly rigid during these movements. Repeat the movement, bending now to the left side. The frame should swing from side to side in a semicircle, and the exercise be performed in a steady manner and not too quickly. Repeat ten times for a beginning. Keep the head well thrown back all the time.

FIG. 123, NO. 21.—CHEST EXERCISE—HANDS AT CHEST, STRETCHED UPWARDS AND TO THE REAR.

This is one of the very finest exercises that can be carried out with a view to tuning up the body to perfect condition.

Position.—Bring both closed hands together in front of chest, elbows close to the body, arm muscles made firm.

Action.—Bend slightly forward, so that the body may receive an impetus in being stretched out as the arms are thrown upwards, inhaling deeply and rising on the toes in order to stretch the frame to its fullest extent. Then swing arms to the rear in a circular motion, keeping them outstretched and applying full pressure upon the shoulders, and bring the arms down, keeping them to the rear as far as possible. Fall back on the heels as the arms are brought behind, at the same time exhaling. Continue the circle forward and upward until the starting position is regained. The knees must be kept straight and the chin raised on the upward movement. Repeat ten times, with a slight pause after each movement.

FIG. 124, NO. 22.—SIDE-BENDING EXERCISE—HANDS AT WAIST.

This exercise is the easiest of all side-bending movements, and is therefore very suitable for anyone whose physical condition does not warrant anything but the most gentle movements at first. A very stout person, for instance, may practise this with entire safety.

Position.—Body thrown back, feet apart, hands at waist, and elbows back.

Action.—Having the body equally balanced on both legs, bend over to the left side as far as possible. Keep the body from inclining forward as you go over, otherwise you would be transferring the work to muscles not intended to be exercised in this particular movement. Exhale as you bend the body down sideways, and breathe in deeply on rising. The upper portion of the frame should be kept quite rigid throughout the execution of the exercise. Repeat ten times, bending to the left and right alternately, with a short pause after each complete movement.

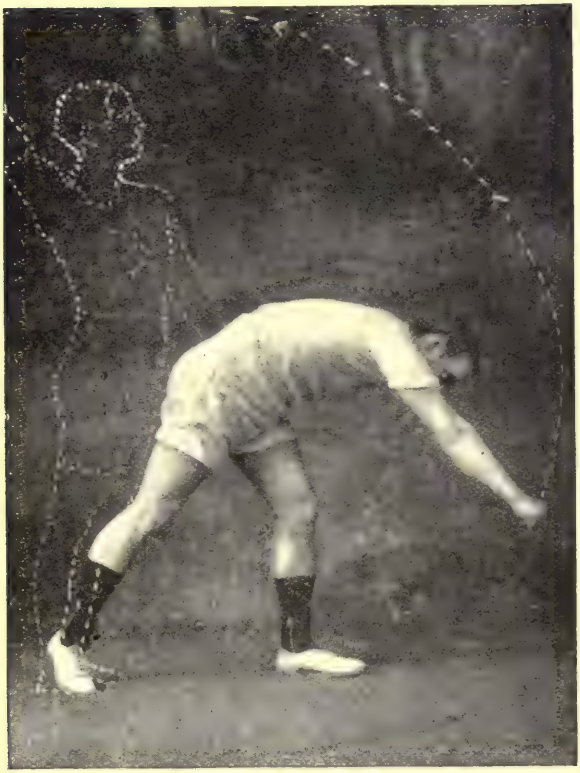


FIG. 125, NO. 23.—FRONT-BENDING EXERCISE—STEPPING FORWARD, ARM OUT.

This exercise has a bracing effect on the spinal column and the abdominal muscles. It also loosens and develops the shoulder muscles and improves the joint action.

Position.—Hands to sides, body thrown somewhat backwards, and feet together.

Action.—Step out with the left foot, throwing the weight on the toes, and as you do so raise the right arm smartly from the rear and throw vigorously forward in much the same manner as in bowling at cricket, only the arm must be brought much farther down. In cricket, also, the swing would stop on the outward stretch, but this is really a double motion.

After having gone down until you are near the ground, bring the arm up again right over the head and down to the rear, as shown by the arrow in the photograph, and draw back the left foot to the starting position. Repeat with the opposite limbs, left arm and right leg. Perform this movement ten times to begin with, throwing more vigour into it as times goes on.

FIG. 126, NO. 24.—THE "ONE, TWO, THREE" MOVEMENT.

This movement brings into play more or less every muscle in the body, but principally those of the chest and shoulder.

Position.—Body erect, head well thrown back, feet together, hands at sides, palms outwards.

Action.—"One": Raise the hands to above the shoulders, elbows well out and in line with the shoulders. This is starting position to the next action. "Two": Extend arms vertically upward, hands high above the head, rising on the toes, and stretching the whole frame upwards. "Three": From this position bring the arms sharply down to the sides by a circular sweep, falling back on the heels. Throughout this exercise inhale on the upward movement and exhale on the downward. While this may seem to be a difficult exercise, it is quite easy to follow if you make a point of getting into Position 1; then, pausing, stretching to Position 2; then bringing back the hands to sides and falling back on heels to Position 3. Repeat ten times.

FIG. 127, NO. 25.—DOUBLE WINDMILL MOVEMENT.

This is an exercise somewhat similar to Exercise No. 5, the chief difference being that the arm muscles are kept perfectly rigid in this exercise, while in No. 5 there was flexion and extension of these muscles. The chest muscles are also worked in quite a different manner.

Position.—Stretch the arms down in front of the body, with the frame bent well forward and chin raised.

Action.—From the starting position lift the arms high above the head, at the same time raising up the frame by throwing the weight of the body forward and rising on the toes. Inhale on the upward movement. Now, without any pause, swing arms backward in a circular motion, allowing the weight to go back and be sustained on the heels as the arms are brought down. The circle should be described and the frame extended as high as possible. Exhale on the downward motion. Perform this exercise ten times. Take time, and do not rush through it.

FIG. 128, NO. 26.—SIDE-BENDING EXERCISE—HANDS CLASPED ABOVE HEAD.

This exercise will be found extremely useful for strengthening the spinal and abdominal parts, reducing superfluous flesh, and giving the shoulders a free swing.

Position.—Stand upright with the arms above the head, hands clasped to sides, and feet apart.

Action.—Bend slowly down to the left side, exhaling, until the hands touch the left foot, and in going down see that the hands describe as wide a circle as possible. Then quickly raise the frame up again, inhaling as you rise, keeping the arms outstretched and the muscles firm, and resume the erect posture. Having filled the lungs, after a momentary pause bend down similarly in the opposite direction. Note that you should bend gently, but rise quickly, as you thereby relieve the pressure which is put upon the frame in the contracted position. Repeat ten times, bending to the left and right alternately.

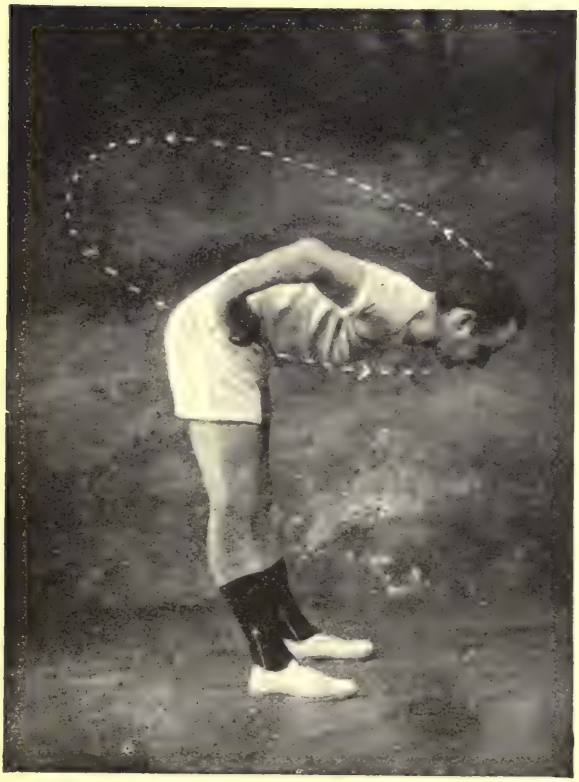


FIG. 129, NO. 27.—TRUNK-ROLLING MOVEMENT.

This movement is a most valuable lower trunk exercise, building up every part, internally and externally, into ideal condition.

Position.—Hands at the waist, head raised, feet slightly apart.

Action.—Incline the hips slightly backwards and bend the body forwards until it assumes a position at right angles with the legs Then slowly allow the body to roll over to the left, then to the rear over to the right, and then around to the starting position again. By this movement it will be seen that the body has completed a circle, the pressure being applied entirely on the waist-line. This exercise, if performed correctly, is sure to cause some degree of dizziness, and to lessen this it is advisable to reverse the movement, allowing the body to circle six times in one direction and then six times in the reverse direction. Another good plan to prevent giddiness is to keep the head up and the eyes fixed on some object straight ahead.

FIG. 150, NO. 28.—STEPPING-OUT EXERCISE—ARMS EXTENDED IN FRONT.

This exercise is designed for loosening the shoulders, strengthening the spine, and improving the carriage.

Position.—Hands clenched at chest, shoulders back, chin up, and elbows well to the rear.

Action.—Opening the hands, step out with the right foot, stretching the arms out in front, throwing the whole body well forward. Inhale as you step out, the weight being thrown on the toes, the heels slightly raised from the ground, the right leg bent as shown in the photograph, and the left leg straight. Pause momentarily, and then step back to the starting position, bringing the hands to the chest tightly closed. Repeat, stepping out with the left foot. Notice that in this movement the back should have free play, the spine being stretched on the outward movement and shortened on the return. This may be done by throwing the shoulders as far back as possible, thereby forcing in the small of the back. Repeat ten times, stepping out with the right and left foot alternately.

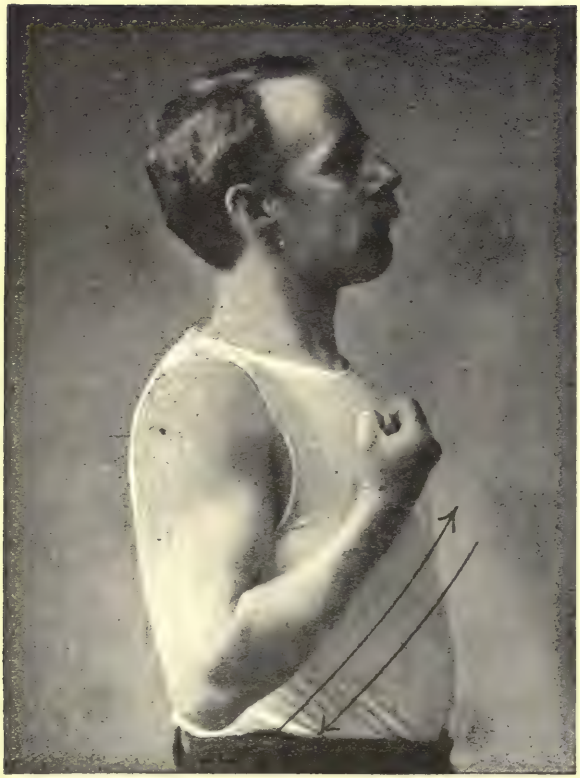


FIG. 131, NO. 29.—UPPER ARM EXERCISE.

This is specially intended for developing the upper arm.

Position.—Stand upright, feet apart, hands at the sides, knuckles to the rear, palms to the front, and hands clenched.

Action.—Make the arm muscles firm, then slowly raise the forearm, right and left arm alternately, putting full pressure on the biceps, until the hand is brought to the shoulder; then lower again, keeping even tension on the muscles. This gives the two extremes of action, applying the muscle pressure equally during the flexion and extension of the arms. To exercise the triceps, when the hand is raised as in the figure, turn it round, palm to the front, and force downwards, putting the greatest pressure on the downward movement. Repeat ten to twenty times.

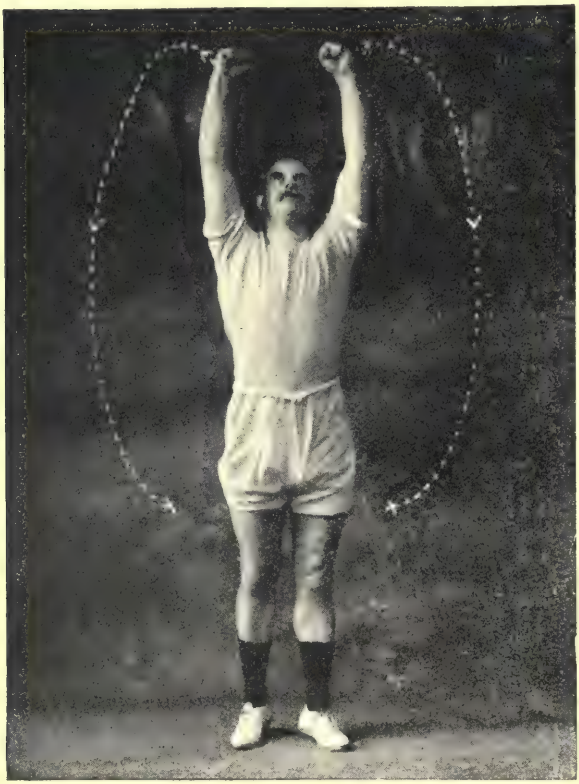


FIG. 132, NO. 30.—SHOULDER AND CHEST EXERCISE—ARMS EXTENDED TO REAR.

This is very suitable for correcting round shoulders, the spinal curvature of adolescence, or undeveloped chest.

Position.—Both arms at sides, arm and shoulder muscles tense, and the whole frame rigid. Keep one foot slightly to the rear to preserve balance, chest out, and shoulders back.

Action.—Having inflated the lungs, raise the arms slowly from the sides, keeping them slightly to the rear until they are high above the head, hands touching, while rising on the toes and stretching the whole frame. Make a slight pause, then bring the arms down again to the rear, and fall back on the heels, exhaling as you go. (You must empty your lungs completely.) Keep the head thrown well back on the upward movement, and on the downward movement bring the head well forward again. Repeat ten times to commence with. Do not change the feet; this is a common error, and there is nothing to gain by it.

Rubs.

The Oil Rub.—The anointing of the body with oil before and after severe exercise, wrestling and the like, is a very ancient practice. The benefit derived may be rather attributed to the massage than to the virtue of the oil, which probably merely acts as an excipient.

The skin circulation is improved and fatigue products driven out of the muscles through the lymphatics, and the blood-flow in the muscles generally is improved. In those subjects whose skin is usually dry and scaly the oil rub is usually a very useful therapeutic measure. Frequently, however, the underlying cause in such cases is hypothyroidism, and the daily administration of a few grains of thyroid extract may be called for. In warm climates radiation from the skin is increased by oil-rubbing, but in cold climates, on the other hand, oil-rubbing lessens the tendency to chill after a hot bath, as the oil surface tends to keep in the heat. Lascar seamen, scantily clad, may be seen almost any winter's day in London or Liverpool docks, braving the rigors of our climate, and this in a measure they are enabled to do by the use of oil inunction. The effect is enhanced if the skin be well washed beforehand with warm water. Copra or olive or cotton-seed oil are the best for the purpose, animal oils giving off an objectionable odour.

The Alcohol Rub.—This is greatly in vogue in America. It is usually applied after some sweating treatment or a douche. About 2 ounces of grain spirit are used; the application acts as a tonic to the capillary circulation in the skin.

The Salt Glow or Rub.—A tub of brine is used along with a supply of the finest powdered salt. A handful of this is taken, moistened, and the patient vigorously rubbed with it, care being taken not to be too vigorous, as a smart erythema may be so caused. After six or eight minutes the patient is douched with warm water, finishing cold. An oil rub sometimes follows.

Ice-Rubbing.—Ice-rubbing is for such conditions as sunstroke and hyperpyrexia, being usually applied to the back of the neck and surface of the spine. A flat lump of ice of convenient size is held in a piece of gauze and rubbed over the part with light friction.

SECTION IV

CHAPTER I

THE REST CURE

THERE are three essential factors in the rest cure. These consist in—

1. Absolute rest in bed.
2. Isolation from friends, letters, etc.
3. Abundant feeding.
4. Massage and electricity.

Weir Mitchell, of Philadelphia, was the first physician who systematically employed these methods in combination; and the late Sir W. S. Playfair introduced the treatment into this country, and used it extensively with great success.

The class of patient in whom the most striking results are obtained are neurotic individuals of either sex who have become emaciated. Some such cases have broken down from sheer overstrain where initially there was not a big supply of nerve energy to draw upon. Others have gradually brought themselves into a condition of ill-health and complete nervous exhaustion from cultivating "diet" fads or leading idle, useless, unwholesome, if not vicious, lives.

Some may evidence the condition known as "anorexia nervosa," and either refuse food, take very little, or, worse, vomit what they do take immediately the meal is finished. Vomiting may alternate with diarrhœa. The emaciation is often slow in such cases, but the ultimate condition of the patient is practically skin and bone; in other words, at the commencement of the "cure" such patients are frequently in a condition of the most profound emaciation.

The following weights are instances:

Female, aged 22 (5 feet 8 inches), weight, 5 stone 12 lbs.
Male, aged 24 (5 feet 6 inches), weight, 7 stone 1 lb.
Male, aged 23 (6 feet 2 inches), weight, 8 stone 3 lbs.

Such patients are usually markedly anæmic, listless, apathetic, depressed, if not tearful; the skin is loose and dry, and mind and body are enfeebled to the last degree.

While they occasionally resent the confinement, and protest at the frequent feeding for the first day or two, they soon become accustomed to the routine, especially if provided with a cheerful and tactful nurse. Any insubordination, if firmly dealt with at the start, usually ceases very speedily, and reasoning with a patient may often do much to this end.

1. **Rest.** — In regard to this factor, it cannot be too forcibly insisted that the rest must be complete. For from four to eight weeks, or even longer in severe and slowly progressing cases, the patient must be kept in bed without intermission, night and day, only leaving it morning and evening to be placed on another bed or couch while the first bed is being made.

In severe cases a bed-pan must be used. Food must be cut up or suitably prepared, and neither reading, writing, nor sewing must be allowed.

The ennui resulting from this severe régime is not so great as one might expect. If good progress is being made, the patient dozes or sleeps a great deal during the day, and two hours' massage, some galvanism, and frequent meals, go far to fill up the waking time.

Any relaxation of the rules will depend entirely on the progress made; but in a case of moderate severity which is doing well some light reading, such as the daily papers, *Punch*, or pictorials, may be allowed at the end of the third week, and, later, sewing or an unexciting novel. Gradually a little sitting up in the afternoon may be also permitted. This period is gradually lengthened, and at the end of the sixth week change to another room, or a walk on a verandah, may be allowed.

A large airy room, well lighted, with a south exposure, is best for such cases. A night and day nurse may be required, but, generally speaking, it is best to have the same nurse sleeping in the patient's room or a dressing-room, and a special masseuse visiting twice daily and temporarily relieving the nurse.

Too much importance cannot be laid on the choice of the nurse. Great judgment is needed in this particular, and the success or failure of the "cure" will largely depend on the nurse's temperament and capacity. She must be possessed of a high degree of patience, and her sympathy must be tempered with discretion.

2. **Isolation.**—This is essential, and must for the first four weeks be absolute. To attempt to carry out this treatment in the patient's own home is worse than useless. The place matters little apart from this, and provided the immediate environment of the patient is cheerful and peaceful, a good nursing home or hydropathic sanatorium is equally suitable. No letters must be written or received, and no person permitted to enter the patient's room except the physician, nurse, masseuse, and the maid who cleans it and attends to the fire.

3. **Feeding.**—As regards diet, the line adopted is an ample supply of appetizing, easily digested food at regular but frequent intervals. Where the patient is very low down and digestion much enfeebled, a start has often to be made with milk or peptonized milk. To some patients this is distasteful in the extreme, while others are completely upset by it, acquire a dirty tongue, and lose weight.

The addition of barley or lime water sometimes helps matters, but to those who have "the indigestion of fluids" described by Fothergill—in other words, a degree of gastric myasthenia—a more solid diet is better suited. A beginning can be made with chicken purée, creamed fish, plasmon cream, and rusks, and the patient gradually worked up to a full diet. All drugs are best avoided, particularly digestive enzymes, etc.: at the most, some mild aperient medicine may be required at first, as $\frac{1}{6}$ grain calomel nightly, while milk is taken.

The following is a typical diet for such a patient:

7.30 a.m.	*Café au lait* and bread and butter.
8.30 a.m.	Tea or cocoa, with cream or milk; two fried sole fillets; toast and butter; jam or marmalade *ad lib.*
10 a.m.	A glass of milk and rusk.
12 noon.	A *whole* cup of beef-tea.
1.15 p.m.	A large helping of chicken or pheasant, vegetables, and milk pudding.
3 p.m.	A cup of Benger's food—½ pint.
4.30 p.m.	Tea, biscuits, and bread and butter, and a boiled egg.
6 p.m.	A cup of beef-tea.
7.30 p.m.	A large plate of meat, vegetables, and pudding, as at lunch.
10 p.m.	A glass of hot milk and a biscuit.

The nurse must see that the meals are served regularly, and should also keep a careful record of how much the patient takes.

It is best to avoid alcohol in any form, malt liquors usually increasing the tendency to biliousness. Tea and coffee should both be used sparingly, and no after-dinner coffee taken. The drinking of ½ pint of milk at each meal should be encouraged, especially if milk is well borne by the patient. Sanatogen may be at times added to it, or Wander's Ovaltine, which many people find very palatable. The food value of milk puddings may be further increased by adding casein powder in the form of plasmon, or the like.

If the milk is found not to be easily digested, raw-meat juice may be given several times a day between meals.

The patient is usually weighed once a week, or sometimes oftener; but care must be taken in many cases to keep the weight a secret, as some patients are unduly depressed if there is a loss of weight or the gain is slow; while in female patients, if the gain be rapid—say 6 pounds in one week—they may refuse to eat so much in case they get *too stout!* This is by no means unusual.

The food is gradually diminished during the last week.

Hale-White and Spriggs have carefully investigated the metabolism of a patient during the rest cure. The food supplied during an eight weeks' course, and the urine and fæces, were carefully weighed and measured. At the commencement the patient's weight was 6 stone 4 pounds, and the gain in weight was 30 pounds. The physiological heat value of a day's food was found to be 5,300 calories. The daily average intake of fat was 268·69 grammes, and 96·5 per cent. was absorbed. The absorption of nitrogen was found to be very complete during the course, only 661 grammes being unabsorbed. It was found, however, that after making due allowance for nitrogen in urine, sweat, and catamenia, there was still 10 per cent. unaccounted for, the explanation being either that these were more concentrated at the end of the treatment, or that the nitrogen was laid up in the form of some compound more nitrogenous than proteid.

4. **Massage.**—The object of the massage is, of course, to take the place of normal physical exercise, improve the circulation, and hasten the removal of waste products from the tissues. The whole body is treated, with the exception of head and face.

Beginning the first day with ten minutes morning and evening, the amount is rapidly increased up to an hour twice daily at the end of the first week, and is maintained at that until the patient begins to move about a little. It may then be gradually decreased until exercise is taken freely. The immediate effect of massage is drowsiness and some degree of hunger, so that it is well to follow the massage with some light form of meal. The patient is then allowed to sleep for an hour, the room being darkened. With female patients the massage to the abdomen is omitted when the period comes on.

Faradism may be combined with the massage, and makes a pleasant change, some patients much preferring the electrical massage. In certain cases central galvanism is beneficial, and we have seen a good many cases get benefit from the high-frequency auto-condensation couch in the later stages, provided the necessary apparatus be near at hand in the same building.

As regards bathing, the limbs of the patient should be sponged daily *seriatim* with cold or tepid water, and dried off with a rough towel. In the later stages a morning spray is most beneficial, provided there be a good reaction.

The results of this somewhat remarkable treatment are equally remarkable, and the improvement in physical health and gain in weight often perfectly astonishing. A very usual increase in weight during a six weeks' course is 1½ to 2 stone. Hale-White records a gain of as much as 9 pounds 12 ounces in one week, and Graham Brown of 9 pounds—the latter with milk alone. These are exceptional, and one should be perfectly satisfied with a steady gain of from 3 to 5 pounds per week.

As in the results of gastro-enterostomy for dyspeptic conditions, the thinner the patients are at the start the more striking is the gain in weight. Indeed, the patients who benefit most in every way are the absolutely emaciated, worn-out neurasthenics. Fat, hysterical types, in whom the *mental* element predominates, do not improve to the same extent; indeed, the gain in weight may become a mere added encumbrance. Any organic gastric trouble, such as an ulcer which bleeds, or enteritis, is a bar to success; but gastralgia and neuralgias of many regions disappear like magic in the vast majority of cases.

Romberg defined "pain" as "the prayer of a nerve for healthy blood"; if a superabundant supply of healthy blood is forthcoming, the pain goes.

If the patient has drug habits, the usual difficulties have to be contended with; but provided the habit is broken off, they do well.

While some weeks may pass before the patient is inclined or able to take a great deal of exercise, still, in the large majority of cases, at the end of the course the patient is in excellent health. Relapses do occur, but much will depend on the after-care of the patient. A sea voyage or stay in a high altitude, as in Switzerland or at a high, bracing place like Buxton or Ben Rhydding, is very desirable.

The Annual Cure.

It is probable that at no time in the history of mankind has an annual, or at any rate periodic, cure been more needed than at the present day. Never was the struggle for existence keener or the pressure of life—and more especially city life—so great. The Great War from which we have hardly emerged has aged most people, and has been an enormous strain on their vital energy, even in those past middle life who have not been actively engaged in the combatant ranks. During the war we have had strikes of short duration, and since the armistice the epidemic of these which has broken out has been an immense addition to the worries of the average business man. This may be considered as a strain superimposed on the ordinary factors which go to damage a man's health, such as overeating and drinking, late hours, and lack of proper exercise and amusement.

These all tend to produce the congeries of symptoms known as neurasthenia—a condition almost unknown, and certainly unrecognized, before the introduction of the railway, the telegraph and telephone, and the joyous automobile. People get this affection in all degrees up to acute neurasthenia, and we describe them as "needing a change," "run down," "below par," or say they "have been overdoing it."

The individual may be of either sex; a votary of pleasure or one who shuns amusement, but whose mind is never at rest; constantly engaged in the pursuit of wealth; or the person may be a man with a highly prosperous business, with various branches and departments, numerous managers, sub-managers, and clerks. Suddenly his right-hand man goes down with typhoid or pneumonia, and he is left for six weeks or more to do practically two men's work.

During this time, possibly, a coal famine occurs, embarrassing his business very materially, and we may further imagine that there is money stringency, and that in this threefold manner his ordinary normal daily worries are multiplied tenfold. The strain of the position is soon felt

even by an ordinarily healthy man: the telephone bell becomes a continual jar on his nerves; the telegrams pouring in are just so many worries clamouring at the door; he becomes irritable and hasty in temper, flies into a passion at a moment's notice about what he would usually consider a trifle; noises ordinarily unnoticed, such as the banging of doors and whistling of trains, jar acutely on his nerves; appetite fails; and finally sleep goes too. The appetite may be flogged on by sherries and bitters, sleep may be coaxed by bromides and the newest hypnotics, his acuteness of care and anxiety may be dulled by the free use of alcohol; but, for the time, a physical and mental breakdown has occurred which no drug can cure, for which "tonics" are useless, and nothing but complete removal from the field of labours, with rest and a thoroughly wholesome natural life, can restore such an individual to his usual good health. Under such conditions many men go off for a month's golfing holiday, and might do much worse; but if thoroughly disordered and broken down, as such cases often are, there is little inclination for much physical exercise; if this be taken to any extent, they become unduly fatigued, the bottle is once more resorted to, and the last state of the unfortunate individual may be worse than the first. It is in such circumstances that a health resort of some kind, with proper medical care, may be of infinite value, and stay the advent of general paralysis of the insane, or some other form of organic disease.

One may cite another case. A woman passes through a time of great strain and difficulty. She may have the trying task of nursing a husband or near relative, and have gone through the physical labour and vigils entailed with the additional emotional excitement, swayed by hopes and fears, and forgetful of, or at any rate denying herself, what everyone requires in the way of fresh air and rest when assaying this arduous task. Thus, whatever the event be for the patient, the nurse grows pale and thin, and looks weary and bloodless. She eats little and digests less, and, getting tired on the slightest exertion, becomes emotional and mentally depressed. Here, again, drugs are quite useless. Change of environment and removal from the

scene of her recent labours and struggle are essential, and a month or so spent in a judiciously chosen health resort under medical care and advice may save her a lifelong invalidism. Many parallel cases might be cited, but these will suffice.

Of cures and health resorts the Continent formerly offered an immense variety; but the war has changed many things, and it is not likely that British people will for many a day care to visit the highly developed German resorts formerly so much in vogue. There remain the French and Swiss resorts, but it has to be borne in mind that many of these are closed in the winter-time, and the journey to reach them may be long and tedious, as well as expensive, the fatigue but serving to aggravate the patient's condition and further delay a cure. One has to bear in mind also that on arrival there is often no English physician, not always even an English-speaking one, so that there is difficulty in establishing that mutual confidence which must exist between patient and doctor if good results are to be attained.

Thus the invalid is now often well advised to consider our home resorts, and such highly equipped bathing-places as Bath, Buxton, and Harrogate, or one of the several well organized and equipped hydropathic institutions which have been built in this country.

Unfortunately, the word "hydropathic" is at once displeasing to some people, perhaps from some unfortunate experience or from report of others. There is a thought of a crowd of noisy people who are rather aggressive, and consider contemporaneous residence under the same roof as an ample introduction, which more staid and reserved people resent.

Most of them, furthermore, have no licence. Then there are the amusements, so called, which are not always judiciously handled. There are practically three types of hydropathic establishment:

(1) The variety which is practically an indifferent boarding-house.

(2) The pure pleasure resort, in which there is no pretence of giving facilities for diet or treatment; and

(3) The best type, which offers all the advantages of the

modern hotel, and which, while in no way a hospital, is so managed and arranged that the invalid can lead a comfortable life and get what he wants done for him just as at a spa.

We may briefly sketch the chief points in an establishment of this nature:

1. The building should be of modern construction and at an elevation of several hundred feet above the sea.

2. It should be situated in the country, away from town smoke, and preferably in open moorland or hilly country, with, if possible, adequate shelter from the north and east.

3. The building should face south, and the rooms be arranged to have a maximum of south exposure.

4. The rooms should be large, airy, and well ventilated, with fires rather than steam radiators for heating, and be lit by electricity.

5. The sanitary arrangements should be of the most modern description and faultless in every respect.

6. The public rooms should be large, airy, and sufficient to accommodate the maximum number of visitors comfortably and without unpleasant crowding.

7. The corridors should be wide and well lighted.

8. The baths should be properly equipped with all modern hydrotherapeutic arrangements and electrical apparatus.

9. The cuisine should be that of a first-class hotel, and proper arrangements should be made for the provision of such special invalid diets as may be required from time to time.

10. A qualified physician should be available in the establishment, with special experience in this particular department of medical work. The advantage to the health-seeker of having a reliable physician within call is obvious; whilst the assistance to the physician of having patients collected near his immediate observation, especially in unusually difficult and obscure cases, is very great. This is an advantage from which the ordinary medical attendant is necessarily debarred. It has been the writer's experience on not a few occasions to have patients sent to be treated by hydrotherapeutic measures for some special conditions, and to find after a week or two of careful observation that the cause of the patient's ill-health was something widely

different, and the special conditions referred to by the medical man merely symptoms of a much more serious disease.

11. On the essential need for good management in every department it is needless to dwell, for the same applies to any house, hotel, or public establishment.

The Use of Drugs in " Cure " Establishments.—As patients placing themselves under the care of a spa physician, or coming to take a " cure," have often been already treated with almost every known drug in any way applicable to their particular condition, it is plainly the reverse of common sense to continue medication which, after careful trial, has produced no benefit. The manifest object in coming to a " cure " establishment is to try what can be done by *natural* methods. It is well, therefore, to start fair and avoid confusion of issues. There must arise from time to time special circumstances under which the prescription of some drug is desirable or even essential, and no blind adherence to any special form of treatment can be expected to lead to the best results. An open mind and eclecticism in method are always best; but patients who arrive with bundles of prescriptions and bottles of physic are at the very start best advised to put away the former and throw away the latter, commencing their treatment *de novo*. Otherwise intellects are confused, and, if the invalids improve, it is impossible to say what is doing them good.

One of the most important factors in the " cure " at any establishment is the attitude of the patient himself. Hopefulness in regard to his case is of course essential, but, in addition, the invalid visitor must be freed from all mental excitement, and from the cares and vexations connected with his home or business. So far as is possible he must leave all these behind him, and reports and letters from managers or partners should be, if possible, interdicted. A man who endeavours to combine his " cure " with negotiations for the purchase of a large estate or a " bull " operation in copper is wasting his time and money, and stultifying himself and the physician under whose charge he has placed himself. The financial column in the daily paper should be studiously avoided.

Indeed, the visitor in search of health cannot do better than lay to heart the old Roman inscription on the baths of Caracalla:

> "Curæ vacuus hunc adeas locum
> Ut morborum vacuus abire queas,
> Hic enim non curatur qui curat."*

The Sea Voyage.

For certain disabilities nothing is more pleasant or effective as a cure than a sea voyage. The author spent several years of his earlier life at sea compulsorily, and with the greatest benefit. There is no doubt but that when a patient is run down from nervous strain metabolism is poor, and there is always a tendency to drop weight while ashore; the complete change of conditions to sea life, with the tendency to laze and take things easily, does a very great deal of good. Care in the choice of route and avoidance of too long trips and too long stretches of tropical weather is highly requisite. It is to be feared that every physician who recommends a sea voyage does not bear in mind the fact that the seasons in other climes are not as our own. Certainly fast steamships do not tarry in the doldrums after the manner of the "wind jammer," but if several of the ports of call are in the tropical or semi-tropical zone, the time spent there may undo all the good of the voyage from the debilitating effect of the heat, and there is also the possibility of a malarial infection.

Perhaps the two ideal voyages are to the Cape and back in an intermediate, slower, but more restful than a mail-boat, and to Rio or Buenos Ayres. Here we have just enough ports of call *en route* to add interest to the voyage, and have also a good long sea stretch, but never more than fourteen days out of touch with land. This is important as regards fresh provisions, and keeps up the interest.

For certain philosophic subjects the sailing-ship voyage may be preferred, to Australia being the usual one; but,

* "Light of heart approach the shrine of health,
So shalt thou leave with body freed from pain;
For here's no cure for him who's full of care."

of course, here monotony may be very trying and the cuisine be too much of the tinned and "harness cask" variety.

Neurasthenics usually improve very greatly, losing their irritability and eating well. As regards sleep, there are always drawbacks on a ship. Many people get quickly accustomed to noises, but all do not. There are many unusual noises on a ship for the landsman—the half-hourly clink of the bell and cry of "All's well" from the lookout, changing of watches, the rattle of the ash-bucket gear from the stokehold, and even the dreary haunting sound of the fog-horn at times.

Few people can sleep with the last going every three minutes, but this mostly happens at the very beginning, before we are clear of the Channel, or on the return. The afternoon siesta on a deck chair or down below is sometimes disturbed on a crowded ship by a tribe of noisy children, but that is a minor matter. The general tendency is towards a new philosophy, the cheerfulness and joviality of most sea-faring folk being rather infectious.

People who lead open-air lives at home and who are accustomed to sport do not take very well to the sea life, and join the crowd of inquirers who periodically ask the captain when he expects to "get there" or sight land.

Sea-sickness has to be remembered, and may be very distressing, but we have known few people who did not get accustomed to the roll or pitch of a ship after three or four days, and modern liners are so vast and so well designed nowadays, with bilge keels and so forth, that with any luck very little rolling or pitching is experienced from port to port.

As a sequel to a rest cure nothing can be finer than a six or eight weeks' sea voyage. It removes the atmosphere of the sick-room and brings the patient back very often quite metamorphosed.

As a therapeutic measure it is not to be forgotten when the physician is baffled by the slowness of a nerve case in getting under way to a cure.

CHAPTER II

OPEN-AIR SANATORIA FOR CONSUMPTION, ETC.

JUST at the close of the last century the public was stirred by an article in one of the monthly reviews, written by a "cured" consumptive, greatly belauding the open-air cure of phthisis pulmonalis as carried out by Dr. Walther at Nordrach, in the Black Forest. Perhaps the article was written with more zeal than discretion, the writer being a special pleader owing to his own, it is to be feared, temporary resuscitation.

It is not too much to say that a great impulse was given to the open-air treatment of tuberculosis by this article, however.

One is old enough to recall the treatment in vogue for consumptive cases at that time and just a few years before. If the patient remained in this country he was kept in a warm "sick-room" in winter, and given an occasional change "down to the parlour"; if he was possessed of means he was sent abroad to Egypt, the Riviera, or Cape Colony.

The treatment of such cases in hydropathics was then carried out frequently, and their transit in crowded passenger steamers, possibly sharing the same cabin with three other passengers—portholes closed—was a positive scandal in the view of our present knowledge and practice.

After 1900 sanatoria started to be erected all over the country, and overmuch was expected. The idea seemed to exist that any case who was made to keep his lungs distended with fresh air and his stomach with food had a good prospect of cure. The fallacy of this has been demonstrated, and we are now more discerning and less optimistic.

The sanatorium is an essential establishment for the open-air treatment of cases of pulmonary tuberculosis for

which there is a reasonable prospect of a cure. It is unfair to send cases which are really hopeless, if not moribund—unfair to the individuals themselves and to the inmates of the sanatorium.

Cases that are seriously ill are better treated, at any rate at first, in a nursing home or in their own home under skilled medical supervision. The purpose of the sanatorium is to receive phthisical patients in any stage which affords a reasonable prospect of a cure, and it is important to decide whether there is sufficient power of reaction to render an open-air life practicable without doing the patient harm.

Further, a sanatorium is a place for tubercular patients, and such patients only. Convalescents and those who are merely run down need not submit to the somewhat severe régime necessarily enforced, nor subject themselves to the risk of infection which undoubtedly exists.

The treatment at a sanatorium consists in the careful regulation of each patient's daily life in all its details. The objective is to enable him to stand a life in the open air in any weather, hardening him to exposure by all possible means, such as hydropathic measures and hyperalimentation. Exercise is regulated according to the special state of his health on the day and the weather prevailing. Often treatment begins by rest in bed until it is found there is no temperature running. Then it has to be established that exercise does not cause a temperature. There is a certain ritual always laid down to prevent infection, for even frankly tubercular cases may get fresh infection or mixed infection, and so get worse. The patient is seen by the doctor at least twice daily, and is under constant observation of nurses specially trained for this class of work. His tendency to do too much is thus restrained; he is encouraged to be hopeful and not to do too little; he is not allowed to "snug around the fire" or shut his window, while treatment of symptoms is prescribed as they arise. The tendency of patients—many patients—to under-ventilate and overheat their rooms has constantly to be combated.

The keynote of the treatment is *open air*, whether the patient is in bed or out of doors. Many patients at first find this life very trying; they may feel miserably cold and

develop chilblains, and become mentally depressed. But in the vast majority of cases they learn to laugh at their first sensations and become acclimatized. It has to be admitted, that some cases do not become so, and these do not flourish in the surroundings of a sanatorium, but they are exceedingly rare.

Rest or exercise out of doors is practised in all but the worst weather—in sheltered balconies, in the first instance, fitted with artificial light for use in the short winter days. Here patients may take their before-meal rest, or spend the evening reading or playing unexciting games. Patients are known to stay out of doors in rain, fog, and snow without harm. At the Victoria Hospital in Edinburgh, the writer was assured some years ago, it was not uncommon to have patients who slept out of doors in the shelters dug out—in winter—quite snowed up. At Banchory the moment the snow stops it is quite usual to have a team of patients in the putting-green clearing away the snow, to commence putting again, and overcoats are seldom worn. Dettweiler states that his patients stay out on an average as follows: 40 per cent. more than seven hours a day, and 6 per cent. ten or twelve hours a day.

As regards hydropathic measures, either the wet sheet is used for hardening the patient or the cold spray. At Banchory when the sanatorium was built the patients all had a spray apparatus fitted in their rooms.

The question of rest and exercise is one of the most important in the treatment, and is adjusted with the utmost nicety to each individual patient. As suggested before, patients who are febrile are kept in bed with absolute rest. If the temperature is very slight, they may be allowed up in a chair or couch in their own room or an open balcony. As the temperature becomes normal their appetite improves, and usually dyspeptic symptoms disappear. Not always so, as some patients are more or less chronic dyspeptics, and in such the feeding question may be difficult, and it may be very hard to get the adequate amount of calories into the patient daily to enable him to gain or even keep his weight and take active exercise.

When walking begins it may be restricted at first to

walking on the level for a few dozen yards only. This is gradually increased by daily increments, and a little uphill work added. The principle adopted is much that of the ancient who wagered he would carry a bull, and by way of training he started with a young bull calf. When the beast grew up he won the bet.

With careful daily oversight by the doctor and regulation according to weather and personal condition, the patient gradually increases his distance and the amount of climbing. Most sanatoria have some arrangement of stages or finger-posts to make the graduating easy. The walk should not be of the athlete's training style, but a leisurely saunter of about two miles an hour. If there be any dyspnœa occasioned, an immediate rest must be taken, and a halt also made if fatigue is being felt. If the fatigue is not easily recovered from or if the pulse keeps quick or there is profuse perspiration, then the walk has been overdone, and a pause for some days may be needed. It is usual to have a rub down with a rough towel after the walk, and sometimes a spray, followed by rest. The longest walk is usually taken in the morning. While walking is excellent and may not pall so soon in a district where the country is pretty and the patient is strong enough to go some distance, it must inevitably pall sooner or later, and it cannot be wholly relied on for exercise unless the patient is to get bored. Out-of-door hobbies of some sort are highly desirable, if not essential—sawing wood, chopping sticks, light gardening, croquet and clock golf, photography, and fishing, though *salmon*-fishing must needs be excluded as being too great a tax on the strength—*if* a catch be made! Horse-back exercise and driving may be permitted if the roads are not dusty, and cycling on level ground. Motor cycling can be ruled out, but ordinary motoring, if the dusty days are avoided, cannot well be objected to. For indoor amusements all the well-known varieties are available up to billiards, but in all this it is important to bear in mind that the highly important feature in many cases, especially at the beginning, is *rest*, physical and mental, and exciting billiard handicaps and auction bridge for considerable points may both do harm.

Patients usually fall quickly into line and defer to the doctor in respect to these matters, many making a hobby of "getting well." But it is to be remembered that at a sanatorium there are all sorts as regards temperament, and restless spirits will break out at times and throw caution to the winds, with the inevitable aftermath of a straight talk from the physician in charge and perhaps a set-back in health. One finds even patients who do foolish things behind the doctor's back, thinking they are rather clever until the day of reckoning comes.

The Dietary.—In the early days patients entered a sanatorium with tuberculosis of the lung, and left it cured or partially cured, but with often dilated stomachs.

The fashion was set at Nordrach of *always* overfeeding—no novelty to a German, whose stomach is seldom empty (in peace-time ?)—and not only were vast quantities of food consumed, but dietetic outrages, such as mixing Rhine wine with milk or taking them one after the other, were perpetrated. These days are past and gone, and while it is recognized that, if possible, there must be a certain amount of hyperalimentation in a case of phthisis undergoing a cure, the pace is not forced. If the patient's appetite is bad he is kept at rest and coaxed into eating, not made to take exercise and bullied to take food which he does not digest. A calorie value of at least 4,000 must be aimed at, and 5,000 if at all possible. Special efforts are necessary to make the food appetizing, digestible, and varied in character, avoiding at all times overloading of the stomach, which will upset the liver and cause depression and a set-back. There is need for constant co-operation of the medical director with the housekeeper. Much valuable work was done by Chapman and Bardswell on dietaries in tuberculosis, and the reader who really wishes to go fully into the subject cannot do better than peruse their book.

In view of the tendency in phthisis to lose weight, there should be a preponderance of fat and highly nitrogenous food in the diet, as there is need for rapid constructive metabolism. Milk, cream, and butter in abundance are essential, and the possession of a home farm is invaluable at any sanatorium, where the dairy work is under control

and cows closely observed. Theoretically they should be tuberculin tested, but unfortunately this is, in the opinion of many agriculturists and even public health authorities, a counsel of perfection, and if not done pasteurization should be carried out as a matter of routine. This does not improve the value of the milk, as something is destroyed in the process which has not yet actually had a name put to it, but is possibly of the nature of a vitamin—"that curious illusory body," as Professor Halliburton terms it.

Milk forms such a very considerable portion of the dietary, however, that unusual care is called for.

Taking the day's food for such a patient, something like the following arrangement of meals is usually followed in British sanatoria:

1. In early morning, on waking, milk, hot or warm, up to 10 or even 15 ounces may be taken. Sometimes, but not often, rum is added. A better addition, however, is a little sodium bicarbonate or sodium citrate, which renders the milk more digestible. To patients who dislike milk, and they are not exceptional, tea made with milk may be given, or *café au lait* (with an accent on the latter!).

2. At 8.30 a substantial breakfast is taken of fish or bacon and eggs, preceded by porridge, and with at least ½ pint of milk with coffee or tea or cocoa; toast or bread and butter, with the butter spread thick; cream always with porridge; jam or marmalade, unless the digestion is easily upset, when they may be best omitted.

3. As a snack in the middle of the forenoon one or two raw eggs beaten up with milk, and perhaps a tablespoonful of brandy, with sugar to taste, may be taken not later than 11.30. This makes a nice change from milk, and is of high caloric value. Alternatively, where there is some indigestion of fluids, raw-meat juice or a raw-meat sandwich made with scraped beef.

4. At 1.15 or thereby a substantial meal, perhaps the biggest of the day, should be taken. Milk soup or one made with beef stock and peas or lentil or beans; several slices of rather underdone meat or a steak and vegetables, with milk or crumb pudding and stewed fruit.

5. At 4.30 afternoon tea with bread and butter and plain cake; not less than 10 ounces of milk.

6. At 7 a meal much as midday, with perhaps the addition or option of fish.

7. At 9.30 to 10 a glass of hot milk and perhaps a cracker, or raw-meat juice or Horlick's or Hooper's milk where fresh cow's milk is not borne.

This dietary, if taken, will make a calory value approaching 5,000 or more, according to the liberality of the helpings.

Patients should be warned not to complicate matters by eating chocolates or toffees or fruit out of hours, as the digestion will be tested to the utmost with this, even if ample exercise be taken.

If the patient sleep badly, he may be given whole beef-tea, beef-juice, Bovril, or malted milk, but it is foolish to wake a patient for extra nutriment. Some patients may be wholly unable to tolerate it, even when begun gradually, either because they cannot digest milk, which nauseates them and gives them a filthy tongue, or the fluid is too great for their capacity and tends to cause gastric stasis. It will be necessary then to drastically cut down the food, perhaps—at first either eliminating the milk or using a milk diet only, if that is best digested and the solids cause discomfort. With patience and tact the dietary will gradually become adjusted to the patient's capacity. The dilution of milk with lime or barley water may help.

The General Construction of a Sanatorium.—Many of the details now considered essential in modern hospital construction have to be carried out in a sanatorium. The hospital idea is paramount, not that of a dwelling-place.

As far as is possible, all rooms for patients face the south, and it is desirable to have a balcony outside at least a portion of them. It has to be borne in mind that in our climate, with many sunless days, balconies have their drawbacks, and tend to make the rooms themselves sunless and in the shade.

Patients who are constantly out of doors during daytime do not need a balcony, but those who are leading a more or less bedroom existence find advantage in it. Those with experience of sanatorium management will support the

contention that each section of balcony should be partitioned off by wire netting or some such division from that belonging to the next room, or various social difficulties arise if the population be mixed as regards the sexes. The administrative quarters can well be at the back, along with the kitchens, etc. Large public or common rooms are not to be advocated, as it is not desirable to give any inducement to patients to stay indoors. At Banchory there is an admirable out-of-door lounge, comfortably furnished, where there is plenty of open air, but no draught.

The whole building should face south or south-east or south-west slightly. Windows should be divided into two vertical panes, on lateral hinges, fixed on a swivel of firm construction, and so arranged as not to rattle. Some authorities lay down that as much as one-half of one side of any room should be made up of window. Inside thick curtains are to be avoided, as they are dust-traps and not easily cleaned. As many people do not sleep easily in daylight, outside green blinds of inexpensive kind, easily cleaned, are necessary in most cases.

The heating should be central, and electric light is almost indispensable. As regards size of room, this is less important than the arrangements for easy change of air. The old allowance of 3,000 cubic feet of air per hour is insufficient, and should be greatly increased up to 15,000 or 18,000 cubic feet per head per hour.

The whole sanatorium should be constructed so as to render cleansing and dusting as simple as possible. All ledges over doors and windows should be avoided, cupboards should be sunk into walls, and all corners rounded over the whole cube of any room. Corridor floors are best made of mosaic—the drawback being it is rather cold and noisy—and room floors of varnished wood, cracks being avoided at all times, and filled up when they occur from any cause. At Banchory, where the whole sanatorium is of wood, the walls are simply distempered, and this is easily and inexpensively done after any patient leaves. Cement walls are equally easy to deal with. On the whole, all pictures, however simple, should be avoided; they are dust-traps, and add to the labour of cleaning materially.

Something of the ritual of a surgical theatre must enter into the whole atmosphere in a sanatorium, and simplicity of furnishing be aimed at in every respect.

All a bedroom requires is a hospital bed-rug on the floor at bedside; sunk-in wardrobe, which is best flush with the wall; and toilet-table—washing being conveniently done in the adjoining lavatory, except with acute cases. The patient is allowed a few memories of home and friends in the way of photographs, and more is not called for in the way of decoration.

Chairs of the public rooms, dining-room, and outdoor lounge, should be simple—Russian bentwood with perforated wooden bottoms, or lounge easy chairs of strong canvas or cane. A maximum of bare but polished floor and a minimum of rug or carpet at all times is best.

It may be advisable to have electric fans fitted to a few rooms to increase the air exchange in hot weather for patients who are acutely ill.

A high-pressure sterilizer is almost an essential in the outfit of the sanatorium; also an apparatus for stoving bedclothes, mattresses, and the like.

The Grounds of the Sanatorium.—Considerable acreage around a sanatorium is desirable, in order that patients may take their exercise to a large extent within them, and avoid the public and often dusty roads. In a comparatively limited area miles of walks may be laid out, where walking can be carried out under a certain amount of shelter from trees. Spruces and larches afford the best shelter; the old idea of the healthful effects of the aroma of pine-trees is largely a myth, or at any rate is not of any special importance. Walks should be modelled on the Pinetum, or Invalids' Walk, at Bournemouth. At Banchory pines abound, and there is admirable shelter all over the grounds, and, indeed, for miles outside of them.

Climatic Element.—Undue stress is not laid at the present time on the value of climate in the treatment of consumption in a sanatorium, as formerly. The successful cure of the disease can be undertaken in almost any climate if the air be pure and the treatment properly carried out.

In Peebles, which has a particularly severe winter climate,

the disease has almost been stamped out, and this as much by domiciliary chalet treatment as by the use of a small sanatorium in the county. At the Edinburgh Victoria Hospital, lying comparatively low and near the sea, the results are most favourable; the hospital is on the fringe of the city, and subject to the "easterly haar" off the sea, and even smoke-clouds with the wind from the south-east.

. The important factor is the systematic routine of a properly organized and well-conducted institution, with the daily observation of a skilled and experienced physician. Bardswell and Chapman cite a case of a young lady who lost symptoms and got almost obese in such an institution, and went to the bad at once when travelling in perhaps more desirable climates.

There is another important reason for curing patients in their own climate. If they are persons of independent means who can winter in Egypt and in the Riviera or Madeira it does not matter, but the average person, if he is cured, has to live and work in the climate he was born in. The proper function of a sanatorium is to turn out hardy, healthy people, who are fit above the average, with a cured chest lesion—not to produce hothouse plants.

There are certain subjects with a tendency to catarrhal symptoms more particularly who may not do so well on the East Coast of Scotland as in a drier, milder area like the New Forest, but these are the exception. A patient who has spent a year at a Scottish sanatorium and is half-way to the cure may feel bored, and do no harm by changing to Davos or Falkenstein for a while, but there are other factors—*e.g.*, there is a new doctor.

Many patients get attached to a sanatorium, and return periodically for an overhaul, and perhaps for some months' sojourn.

As regards foreign sanatoria, the fatigue and difficulty of the journey has to be borne in mind, and the greater expense. The patient is also isolated more than ever from his friends, and visits will be few and far between. Above all, there is a strong objection in the case of patients who are really ill, and in whose case the odds are against recovery. It is an unnecessary hardship to patient and friends alike.

CHAPTER III

CLIMATIC TREATMENT

THE importance of climate in health and disease must not be overlooked in the consideration of the various forms of physio-therapy. Many diseases and disabilities are favourably affected by the right kind of climate, which it lies within the province of the physician to select.

Great care is needed, for while we can quickly rectify a prescription on a hint from the patient or the dispensing chemist, if we order a patient to an unsuitable climatic environment, the realization on his part, which may be gradual, with attendant loss of time and expense, will imperil his confidence in our judgment, and, indeed, may constitute an unforgivable offence.

If we consider the intelligentia among the public, many of them with means and leisure are as well or better informed as regards the suitability of various health resorts than many of our profession—from practical experience on their own *corpora vilia*. Nevertheless, the general practitioner, whose knowledge at the present time must be encyclopædic, is often consulted about health resorts and where to get a suitable change of air. Thus his responsibility is considerable either in advising or condemning. His knowledge can scarcely be acquired from books, or, if so obtained, is very different from practical acquaintance with different localities.

The word "climate" is used to indicate differences which exist between one place and another as regards temperature and its variations, as regards rainfall, the density and pressure of the atmosphere, prevailing winds, the chemical composition of the atmosphere, and the organic and inorganic substances it contains.

One of the most important factors is, of course, the amount

of sunshine, and this has direct relation to the distance from the Equator. We have—

(1) Hot or warm climates, extending from the Equator to lat. 35, with a mean annual temperature of 80° F.

(2) Temperate climates, extending from 35 to 55 degrees of latitude, and a mean annual temperature of 60° F.

(3) Cold climates, between 55 N. and the poles, with temperature varying from 5° to 40° F.

But for practical purposes we have to consider them in greater subdivision than this, and may class them into seven varieties:

1. The hot climate.
2. The temperate climate.
3. The cold climate.
4. Insular climate.
5. Maritime climate.
6. Continental climate.
7. Mountainous climate.

Hot climates we seldom prescribe: they are rather endured than sought for by the white races, and have tropical diseases added to the ills which such flesh is heir to. On the other hand, the *temperate* climate is the healthiest on the globe, neither extremes of heat or cold being experienced. Temperate climates lie mostly between 35 and 55 degrees, with a mean temperature of 50° to 60° F. They have the four seasons—spring, summer, autumn, and winter—and there is among them a great variety of *local* climates, such as we see in our own home health resorts.

Cold climates, from lat. 55 to the poles, may again be divided into cold, very cold, and glacial, but these, like hot climates, are not of any special therapeutic interest.

Insular climates are valuable and remarkable for their equable seasons, owing to the surrounding water: the air is humid, and constantly changed by varying breezes.

The *maritime* climate is similar. It is warmer in winter and cooler in summer than the Continental climate, the temperature increasing as we go inland. The Continental climate has a tendency to extremes of temperature, with very cold winters and hot summers.

In mountainous climates we find the air rarefied and the barometric pressure low, and getting lower as we ascend. The air is cooler and exceedingly pure.

Factors in Climate.

The Composition of the Air.—In 100 volumes nitrogen forms 79·00, oxygen 20·96, and carbonic acid 0·04. As is well known, the percentage of CO_2 in air varies greatly—as much as from 4 to 30 vols. in 10,000.

The temperature of the air has also a marked influence on climate. The nature of the surface of the ground also exercises great influence on the amount of heat which is absorbed and reflected. The nearer the colour of the ground approaches to white—as, for instance, chalk soil, snow, etc. —the more the solar heat reflected and the less absorbed, while with dark ground—earth, grass, and leaves—more is absorbed and less reflected. Conversely, during the night the ground which absorbs most heat by daytime gives out most.

In maritime districts the temperature is so far stabilized, and we get what resembles an insular climate, while in hilly regions the mean temperature is low and there is often a big range of temperature. In the Engadine this is very marked, it being necessary to adapt the clothing carefully to different times of the day in winter, especially with people who easily catch a chill.

A further influence is barometric pressure, for if this be considerable it exercises a marked influence on some individuals. It always increases the amount of H_2O and CO_2 exhaled by the lungs, and may induce laboured respiration; there is less capacity for taking exercise, and many people suffer from depression and constipation. Winds tend to purify the atmosphere, and lead to changes in temperature, atmospheric pressure, moisture, and light. They are therefore very important factors in the climate of any locality.

The humidity of any atmosphere varies with the amount of condensation and evaporation which goes on. As a rule, absolute humidity is greatest with a high temperature, but relative humidity is greater in winter than summer. When

the air is saturated we get mists and clouds—clouds generally at average heights, mists on plains and in maritime districts.

Rainfall varies enormously in different parts of the habitable globe. It rises from zero or near it at the Sahara to nearly 400 inches per annum in Assam and the Himalayas. In Great Britain the wettest districts are Glencoe and Ballaculish and Seathwaite in the English Lakes.

Rainfall is not necessarily injurious to a climate, as it helps to purify the atmosphere, but in estimating a climate we have to consider the amount of rain per annum, the number of rainy days, the rainy season, and even the time of day when rain mostly falls.

In the treatment of disease climate is a specific in few, if any, but a change of climate may have the most favourable influence, and in certain affections a very few miles may make a lot of difference. This is so, for instance, in asthma and rheumatism. The situation of the patient's home in an unfavourable locality for either of these affections—the effect on asthma varying enormously with the individual—may perpetuate and aggravate the disease, while a removal to a more suitable environment may be the first step to recovery.

Diseases of the lungs apart from pulmonary tuberculosis are favourably influenced by a mild, moist climate.

The late Norman Hay Forbes formulated the following rules for the choice of climate for any individual patient:

1. Information must be obtained that the general sanitation, water, and food-supply of the proposed resort are above suspicion. It is well to remember that a change means not change of air alone. If *cœlum non animum mutant*, food habits, occupations, environment, with mental occupations and interests, usually are changed—mostly, in all probability, with benefit.

2. The local features of the climate should be ascertained —*e.g.*, local characteristics of temperature, relative humidity, rainfall and sunshine, wind, especially local currents and shelter from winds, barometric pressure, and the amount of cloud.

3. An important point at all times to bear in mind is

that the most fundamental point in the action of climate is its influence on tissue change.

4. Remember that different individuals react quite differently from the same external conditions, and it is true also climatically that "one man's meat is another man's poison."

5. Therapeutically climates are best classified on a physiological basis, according to the demands made by the climate for the production of heat, which is another way of saying tissue change.

6. It is useless—indeed, worse—to prescribe "a good bracing climate" for a delicate and weakly convalescent, whose metabolic powers are unable to respond to the demands of such types of climate.

7. What suits the prescriber will not always, perhaps seldom, suit his patient; and, further, one must bear in mind that of all therapeutic measures at our disposal climate alone is uninterrupted in its action.

8. We cannot prescribe particular climates, like drugs, for special diseases. Health resorts must be chosen on scientific and rational grounds; empiracy is out of place and dangerous.

9. The type of medical man available locally is of very great importance, and there is much to be raised in objection to the foreigner.

10. When a British health resort, therefore, is likely to fulfil all the ordinary requirements of any special case, it is better to have the comforts and familiar conditions of our own country rather than subject the patient to a long Continental journey and the more or less general inconveniences of a foreign country.

11. The average amount of bright sunshine, the relative humidity, the equability of temperature and pressure, the rainfall and prevailing winds, must all be taken together in estimating the therapeutic value of a climate, and no single element should be allowed to acquire a place of disproportionate importance.

The climate of the British Isles (lat. 50 to 60 N.) belongs to the moderate or insular type, which is mainly dependent upon the presence, the temperature, and the motion of the

sea which washes our shores. The chief feature of the climate is the absence of the actual extremes of heat and cold. Indeed, the British climate is relatively equable, owing to the humidity of the south-west winds which are so prevalent. Our summers are cool and moist; our rainfall, lowest in April and highest in November as a rule, though considerable, is not such that it can be regarded as a serious defect. Our southern resorts are comparatively cool in summer and warm in winter; our mean maximum temperature is reached in July or August, and the mean minimum in December or January, which latter is often the most stormy month of the year.

Our inland resorts are warmest in summer and coldest in winter, and the relative humidity is, as a rule, highest at inland stations and lowest on the sea-coast, which is also less cloudy on the whole than inland districts. During spring, autumn, and winter there is more cloudiness, which entails sunlessness, in the south-west districts, while in the summer the least cloudy areas are to be found in the southern districts and coast-line. The prevailing winds are south and south-west, but winds from the north-east are most prevalent in April, May, and June, the last month being usually the driest. In Great Britain the greatest differences from local climates arise from differences in the rainfall and the direction of rain-bearing winds in their relation to the physical configuration of the surface. This latter is undoubtedly the key to the distribution of the rainfall in the British Isles. As regards the influence of soil on the rainfall and our climate, we find heavier rainfalls in the upland and mountain districts, while the general geological structure and contour of the land surface have a local influence on temperature.

The chief geological formations which have an indirect influence on climate are roughly the dry pebble beds, the sands and sandstones, the cold, damp clay, and shaly soils, and the porous limestones. It must not be forgotten, also, that while the soil influences climate, the latter produces certain marked effects on the rock formation and superficial soil, as well as on the configuration of the land generally.

Whatever climate we select, it has to be remembered

that there is no perfect climate, and that no health resorts can claim the monopoly of cure of disease in any form. Few climates are suitable all the year round for the diseases most likely to benefit by their influence.

Weber laid down a principle, which is probably very sound, that a climate with constant moderate variations in its principal factors is the best for the maintenance of health, and such is the climate of the British Isles, often rainy and windy, but for all that healthy and tonic.

A brief survey may be made of the diseases in which climate is an important contributory factor.

In cases of *albuminuria* (*functional and nephritic*) mountain or moorland air has a favourable effect, and districts like Hindhead, Crowborough, Ilkley, Moffat, and Church Stretton, occur to us. In cases of chronic parenchymatous nephritis, as well as early granular kidney, we may find it best to send the patient away for the winter to Northern Africa, the Canaries, or West Indies. If this is either unnecessary or unpractical, we should consider Ventnor, Sidmouth, Falmouth, Penzance, Tenby, West Kirby, Worthing, or Folkestone, in this country, for winter, while in summer Malvern, Matlock, Buxton, and Llanwrtyd Wells, are suitable.

In *primary anæmia and chlorosis*, in addition to rest and medicinal treatment, as well as hygienic and dietetic measures, benefit will usually be derived from residence in summer at some inland hilly resort of moderate altitude (Braemar, Buxton, Church Stretton, Harrogate, Llandrindod Wells, Matlock, or Trefriw Wells, with its chalybeate springs): while certain seaside resorts, such as Brighton, Broadstairs, Cromer, and Eastbourne or New Quay, are also of value, more especially in summer, while in winter Bexhill, Budleigh Salterton, Ventnor, and Salcombe, are to be preferred. Of foreign resorts, Montreux, Vevey, or Glion in Switzerland, and Arcachon, Biarritz, or Grasse in France, are advised.

In hyperpyesis or the involutionary form of arteriosclerosis, Clifford Allbutt advises a mild equable climate, such as Leamington, Worthing, Sidmouth, Lyme Regis, Torquay, and Falmouth.

On the other hand, where there is extensive and advanced arterio-sclerosis with associated troubles, such as asthma and chronic myocarditis, places such as Hastings, St. Leonards, Bexhill, Worthing, Bournemouth, Sidmouth, and Falmouth, are best suited. Asthma, whether of neurotic, bronchial, cardiac, or renal origin is benefited, as a rule, by a comparatively low or moderate altitude. It is difficult to say what exactly will suit an individual asthmatic, as they differ so greatly, and some do well in large towns. Many find the Hampstead region an Elysium, while others, again, are never so well as when in Paris. As a broad rule, both in summer and winter there is much to be said for the Speyside district—Grantown-on-Spey and Nairn; also for Hindhead (800 feet up) and Haslemere or Malvern, where a great variety of altitudes is available. Of seaside places, Broadstairs, Worthing, Newquay, Sidmouth, Ventnor, Paignton, and Torquay, are best suited. For chronic winter cough and bronchial catarrh and the "nervous cough" associated with neurasthenic conditions one of the following resorts will answer: Bexhill, Church Stretton, Folkestone, or Malvern. Of inland spas, Bath, Cheltenham, and Leamington, suit chronic bronchitics in winter; while on the coast such places as Bournemouth, Sidmouth, Broadstairs, Worthing, Torquay, Falmouth, and Tenby, are advised as regards the South; while in the North Rothesay, Grange-over-Sands, and Llandudno, are best suited. If the patient's tastes are for foreign resorts and his purse allow, there are various suitable spots on the French or Italian Riviera, such as Pau, Hyères, and Cimiez; Mustapha in Algiers; Taormina in Sicily; Assuan in Egypt; Arcachon in South-West France; or the Canary Islands—these are all suitable, and the selection of any one must be largely a matter of individual taste.

For diabetics and milder forms of alimentary glycosuria such places as Leamington, Cheltenham, Bath, Clifton, or West Kirby (on the Dee), are suitable; while abroad they resort with benefit to Contrexéville, La Bourboule, Marienbad, and Vichy.

Dyspepsia is such a hydra-headed affection both as regards causation and symptoms that it is difficult to give

any broad statement as to health resorts. Where there is gastric catarrh, however, benefit is derived from the mineral-water treatment, the dietetic regimen, and physical exercise obtained at places like Harrogate, Llandrindod, Bridge of Allan, and Strathpeffer.

The fine air of Folkestone, Bexhill, or St. Leonards in winter does good to atonic dyspepsia associated with brain fag and overwork, physical or mental. Such cases come under the heading "gastric neurasthenia." In summer they benefit from places like Cromer, Hunstanton, Holy Isle, Westgate-on-Sea, Peterhead, or Stonehaven as regards seaside resorts; Peebles, Malvern, Church Stretton, Crowborough, and Hindhead, Buxton, Braemar, or Ilkley.

All the above resorts are well suited to convalescence after acute illness or operation, patients gaining weight and taking their food with gusto as a rule. The only point to bear in mind is the season of the year, some of the higher resorts, such as Buxton and Peebles, being snow-bound in winter.

Patients troubled with chronic disease of the middle and internal ear, particularly those with tinnitus, are best suited by a dry, bracing inland air at a good altitude. Increased humidity, such as is usually experienced at the seacoast, on the other hand, aggravates this distressing trouble in many instances. A prolonged sojourn in the Surrey hills or highlands of Hampshire or at Crowborough is advisable.

Chronic eczema and various other skin affections are helped by visits to such spas as Buxton, Harrogate, Llandrindod, and Strathpeffer, climate and waters, with proper regimen, all tending to a cure.

Gout and chronic fibrositis of all types similarly benefit most by the combined climate and balneary treatment, such resorts as Buxton, Bath, Leamington, Harrogate. Cheltenham, Llandrindod, and Strathpeffer, being advised. On the Continent Aix and Vichy, Vittel, Bad Gastein, Royat, and Wiesbaden, are much in vogue, but it is questionable if they have more to offer than our larger British spas either in climate, baths, or skilled physicians of long experience in this class of disease.

Chronic headaches of an intractable kind are often beneficially affected by a change of climate, and a visit to one of the moderately bracing upland districts, such as Church Stretton, Hindhead, Crowborough, Chagford, Peebles, or Moffat, is advised.

Cases of insomnia are favourably influenced by such resorts as Matlock, Peebles, Moffat, Malvern, Hindhead, and Church Stretton, inland, or at coast resorts such as Bexhill, Bournemouth, Hastings, Torquay, Sidmouth, Nairn, and North Berwick.

The climatic factor in pulmonary tuberculosis has been so far dealt with under Sanatoria, but we may devote a few further remarks to it here. There are four main types of climate to consider:

1. Forest and woodland country, with a moderate elevation of 150 to 1,500 feet. Probably most of our British sanatoria come under this head, with greater or less proximity to the sea-coast. The advantages to be mentioned are purity of the air, the pleasant pine-wood atmosphere (not to be overvalued), freedom from dust, and shelter afforded by the trees. Given a well-conducted sanatorium, no patient can want more.

2. The sea-coast has the advantage of pure and often bracing air, moist, with a more steady temperature than on the hills and a large amount of sunshine. There is a sedative effect on nervous patients, but some subjects get bilious easily. Land and sea breezes have to be borne in mind, which may be boisterous and trying to feeble patients. One may mention in this connection Bournemouth, the Norfolk coast, Sidmouth, Newcastle, Co. Down, and Grange-over-Sands (Meathop), and abroad the French and Italian Riviera, Biarritz, Arcachon, Canary Islands, and West Indies.

Sea voyages come under the same heading, but here much care is needed. As Sir Douglas Powell said to a patient once on the suggestion: "Do you want to be sea-sick?" This has to be remembered, along with the fact that, though the deck atmosphere is good, that of the cabin is bad, and the patient may have to spend a lot of time there. Speaking from experience, the writer's im-

pression is unfavourable; hæmoptysis in crossing the tropical zone is common.

3. Desert climates with a maximum of heat, sun, and, dryness, such as Luxor, Biskra, Assuan, and Heloaan suit some people and have a good psychic effect, but dust-storms are very hurtful and occur periodically. A visit is a pleasant change to subchronic cases where means have not to be considered.

Heart Disease.—In chronic compensated cases, in addition to such therapeutic factors as rest, regulated diet, exercise, medicinal treatment, and special methods, such as the Nauheim baths and the Oertel terrain cure, the consideration of climate will arise. Of inland resorts, suitable places are Leamington, Bridge of Allan, Aboyne, Ballater, Lower Deeside, Buxton, Church Stretton, Llangennech Wells (600 feet), Matlock, and Peebles; as regards coast resorts, Rothesay, Grange-over-Sands, Southport, Seaton, Sidmouth, Falmouth, and Broadstairs, suggest themselves.

Care is necessary to see the locality possesses an adequate number of level walks and of gradually sloping walks, all with some degree of shelter from the prevailing wind. Places with frequent, quickly rising gales, like some of our coast resorts, are, of course, unsuitable, as the patient may have to struggle back against a head wind, with very bad results.

In neuralgia which has lasted a long time and refused to yield to drugs change of air may do much good, a change from the East Coast to an inland or South Coast resort being often followed by good results. Buxton, Leamington, Hastings, or Bournemouth, can be tried; or Braemar, Blackpool, or St. Anne's, Hindhead, or Church Stretton. The same applies to the severe neuralgic pain observed after recovery from herpes zoster.

Neuralgia or cachexia after malaria is favourably affected by a stay at such places as Buxton, Harrogate, Matlock, Church Stretton, Peebles, or Trefriw (where the waters are distinctly beneficial for associated anæmia).

In neurasthenia many factors have to be taken into account in advising any climatic or balneary cure. No two neurasthenics are alike, and while many will do well at a

busy spa like Harrogate, where there is much life and brightness, others will vote it, as they have in my own experience, "a nasty, vulgar, overcrowded place!" If the case is severe, quieter places are better, for a start at least, such as Ilkley, Malvern, Hindhead, Crowborough, Moffat, or Braemar; while of seaside resorts, Cromer, Folkestone, Broadstairs, Hastings, Felixstowe, Newquay, and Hunstanton, suggest themselves. Brighton, along with Harrogate and North Berwick, will do for the less acute cases. On the Continent, the best resorts for such cases are Arcachon, Grasse, Château d'Œx, Montreux, Pau, San Remo, Divonne.

In the treatment of obesity, diet, the terrain cure, and baths having been prescribed, such resorts as Harrogate, Leamington, Malvern, and Church Stretton or Peebles, are suitable. Before the war, Carlsbad, Marienbad, and Homburg, were greatly in vogue, especially in obese persons with some glycosuria.

Rheumatoid disease requires special consideration, and a bright, sunny, dry climate must be sought, with a sand or gravel soil and efficient subsoil drainage. Buxton, Droitwich, Nantwich, and Harrogate, are only suitable for such patients in summer; if they can stand the moister air, Hunstanton or Broadstairs can be tried: but in winter, the purse permitting, Château d'Estoril (Portugal), Seville, Biskra, Monte Carlo, and Assuan, are very suitable, and often help a great deal, balneary facilities being available at most of them.

SECTION V

ELECTRO-THERAPEUTICS

CHAPTER I

GALVANO-FARADISM

Historical Summary.

ELECTRO-THERAPEUTICS date back to a legendary age. It is recorded that centuries ago the women of Africa bathed their sick children in waters frequented by the electric eel, or torpedo (*Malapterurus electricus*); while Actius, in the year 500 B.C. states that those suffering from gout or convulsions found great relief by holding a magnet in the hand, and earlier still the Romans employed electricity in the forms then available in the treatment of disease. Scribonius Largus, during the reign of Tiberius, used electricity in the treatment of gout. Crookes humorously attributed the death of Tullus Hostilius, who, according to Roman mythology, was struck dead by one of Jove's thunderbolts, to accidental contact with "a live wire."

Pliny and Dioscorides both refer to the remedial power of electricity. The history of electro-therapeutics may be divided into four eras—(1) The era of franklinization; (2) the era of galvanization; (3) the era of faradization; (4) the era of radiology, etc.

1. **The Era of Franklinization.**—One of the prominent advocates of, and writers on, franklinic electricity as a therapeutic agent was John Wesley, the divine. At a time when the medical faculty were inclined to despise electricity and underrate its value (as, unhappily, many doctors are still inclined), Wesley claimed that electricity was indicated in a wide range of disorders; and with the list of ailments which he drew up as suitable for electrical treatment the more modern physician who has studied electricity will

find little fault. Quite independently of Franklin, Wesley suggested the use of lightning-conductors.

2. **The Era of Galvanization.**—This was commenced by Galvani's classical experiment on the frog in 1786. After his results were made public, Volta was attracted to the field of electrical experiment, and constructed his pile, which from the year 1800 onwards was largely employed in medical work, and marked a distinct advance in technique.

Unfortunately, most of the work at this period was done by laymen, who knew little or nothing of physiology or medicine. "Chemists, physicists, priests, paupers, monks, and mountebanks, were the leading authorities on electro-therapeutics in the eighteenth century."

Many years elapsed before electro-therapy attained sufficient precision to command the attention of men of science.

3. **The Era of Faradization.**—Michael Faraday's discovery of the principle of electrical induction in 1831 may be said to have changed the whole course of electro-therapeutics. In the following year the first practical machine on this principle was made by Pixii, and used by Neef of Frankfort in the treatment of disease. From this time faradic electricity became extensively employed throughout Europe. Until 1895 galvanism, faradism, and perhaps to a less extent static electricity, were the forms employed in medicine. The apparatus required was not very elaborate, and the amount of work done in a large general hospital was often scarcely sufficient to justify the existence of a special electrical department.

4. **The X-ray Period.**—The discovery of X rays by Professor Roentgen in 1895 undoubtedly gave an enormous impetus to electrical work, and led to the establishment of a radiographic and electrical department in all large hospitals. The field for the electro-therapeutist expanded, and electrical treatment, to some extent, was taken out of the hands of the "medical electrician," or electrical quack.

Soon after this remarkable results were obtained by d'Arsonval, Elihu Thomson, and Tesla, by the use of "high-frequency" currents, which rushed into fashion and acquired a permanent place in electro-therapeutics, along with many other devices.

Electrical Units.

The **Volt** is the practical unit of electromotive force, and is the electrical pressure which, if steadily applied to a conductor whose resistance is 1 ohm, will produce a current of 1 ampere, and which is represented by 0·6974 part of the electrical pressure between the poles of the well-known Clark's cell when at 15° C.

The **Ohm** is the practical unit of resistance, and is the resistance offered by a column of mercury at 0° C., 14·4521 grammes in mass of constant cross-sectional area, and of length 106·3 centimetres.

The **Ampere** is the practical unit of current, and is the constant electrical current which, when passed through a particular solution of silver nitrate in water, deposits silver at the rate of 0·001118 gramme per second.

The **Watt** is the practical unit of power, and is the rate of doing work when a current of 1 ampere flows between two points having a difference of potential of 1 volt, and is the product of amperes into volts.

The **Coulomb** is the unit of quantity, and is the quantity of electricity that flows per second past a given point in a conductor which is carrying a current of 1 ampere. The more practical unit is the **Ampere Hour,** equal to 3,600 coulombs.

The **Farad** is the unit of capacity, and is the capacity of a condenser which would require a charge of 1 coulomb to produce a difference of potential of 1 volt between the two conductors forming the condenser. The practical unit is a **Microfarad.**

The **Henry** is the unit of inductance, and is the inductance in a circuit when the current is changing at the rate of 1 ampere per second, producing in that circuit a difference of potential of 1 volt.

In order to render the above units more clear to those who are not acquainted with electrical nomenclature, we might compare them with that of a hydraulic system, which to the minds of many is more palpable. The dynamo, which we will describe later, may be considered as a rotary

pump pumping electricity instead of water, in which case we have a pump (dynamo) forcing water (current) at a certain number of pounds pressure (volts), as indicated by the pressure gauge (voltmeter), to overcome the friction (resistance) of pipes (wire) in order that the water (current) may flow at the rate of so many gallons (amperes) per minute, as recorded by the water-meter (ammeter). The larger the pipe (wires), the more water (current) can be carried, and the less will be the friction (resistance). Obviously the pipe (wire) might be so small that the friction (resistance) would absorb a very large proportion of the power of the pump (dynamo), having but little remaining for useful effect. If the pipe (wire) be too large, it will cost too much; if it be too small, the loss be will too great. The pipes (wire) require valves (switches) to regulate and direct the water (current), with fittings (contacts) sufficient to convey the water (current) without leak (drop of potential), and safety relief valves (fuses) must be provided to prevent damage from overpressure (voltage). The continuous current is similar to a pump drawing water from a reservoir and forcing water through a system of pipes, upon which the machines may be connected to do work and the water returned to the reservoir.

The alternating current is similar to a plunger pump forcing water through the pipes on the out-stroke and drawing it back again on the in-stroke, the action being repeated with great rapidity (periodicity).

Current derived from a Battery.

Wet cells have now fallen into almost complete desuetude if we exclude accumulators or storage batteries. The cell used almost universally now is of the dry type of Leclanché. We must confess a weakness for the wet bichromate cell, for a small Spamer Battery, the elements being zinc and carbon, with a solution made up of 1 ounce of bichromate of potash, 1 ounce of bisulphate of mercury, and 2 ounces of strong sulphuric acid in a pint of water, as the excitant, but there is *always* the risk of spilling and injuring the battery. With a dry Leclanché we have no such risks.

There is no creeping of salts either, as with a wet Leclanché, causing erosion of the wires and binding-screws. They are also light, which is of great importance in a galvanic battery, where as many as forty cells may be needed.

Probably the best-known types just now are the Obach, made by Siemens, and the Hellensen. A small battery is put on the market by Davidson, of Great Portland Street, known as the Davon, which is wonderfully powerful for its small size. Another of the same type, and equally good, is that of Bruce, Green and Co., Bloomsbury Square, W.C. This is oblong in shape; others are either square or round —fitting better into a box, of course.

The main disadvantage in these cells is, they cannot, as a rule, be recharged when they are exhausted, but Wilfred Harris makes a practice of freshening them up by putting

Fig. 133.—Dry Cells.

them on to the main like an accumulator; the effect is, of course, only temporary. They can easily be sent by post, which is a very great advantage.

The voltage of a Leclanché cell is 1·5. The number required in a battery will chiefly depend on the use to which it is to be put; 50 to 80 volts will be required for treatment purposes.

The batteries themselves are of various types, from the simplest, as far as possible foolproof, suitable for nurses' and inexperienced people's use, to the most highly finished and equipped.

The Leclanché Cell.—The *wet* type consists of a square glass jar and an amalgamated zinc rod in an electrolyte of sal-ammoniac solution, and a depolarizer consisting of manganese dioxide contained in a porous pot. In the

centre of this is the positive pole, a carbon rod. The solution consists of 6 ounces of sal-ammoniac dissolved in a pint of water.

It is important that the zinc rod be amalgamated, to prevent local currents, which cause disintegration. A new one, however, can be procured for about sixpence, and should always be obtained if the old one is at all corroded. Creeping of the salts can be prevented so far by brushing the upper inch of the glass jar with melted paraffin wax. If it happens on the zinc rod, it should be scraped with an old knife.

These cells are not portable, but they are easily cleaned and kept in order, and have a fairly high E.M.F. For medical work, however, they cannot compare with *dry* cells, some of which, if not used, only lose 5 per cent. of efficiency in six months. In these the negative plate is a zinc cylinder with a wire soldered to it; it is also the container of the electrolyte. The sal-ammoniac is not in solution, but in a paste made up with glycerine, water, and plaster of Paris. The depolarizer is solid also, being a mixture of manganese dioxide, sal-ammoniac, and glycerine; this encloses the carbon positive plate, and is contained in a cotton bag inside the zinc cylinder. The top of the zinc container is then closed up with melted pitch.

These cells are extraordinarily reliable, portable, and inexpensive. In one type or another, made by different manufacturers, they have entirely displaced wet cells in all classes of electro-therapeutic work, if we exclude the electric cautery, which hardly comes within the province of this volume.

Accumulators.

Most people have a nodding acquaintance with storage batteries nowadays, owing to their frequent employment in connection with motor-cars for lighting purposes, etc. They are extremely useful where the main supply is not immediately available on the spot, but where charging facilities are within a reasonable distance. They have, further, a very low resistance, so that fairly large currents compared with dry cells can be obtained on ordinary low

voltages, which renders them very suitable for many medical purposes, such as operating cautery and light and portable X-ray apparatus. The voltage per cell, when newly charged, is approximately 2·5 volts, but very soon falls to 2 volts after discharge begins, and there remains till practically discharged, which should, however, never be allowed to fall below 1·8 volts per cell before being recharged, otherwise what is known as sulphation of the plates will take place in a very short space of time.

In the ordinary technical sense they are essentially secondary batteries—that is, a reversible couple. Such combinations may consist of a soluble cathode and an insoluble anode in an alkaline or acid electrolyte, such as zinc-lead, zinc-copper, and lead peroxide couples, but owing to the solubility of one of the electrodes, or both, renders this type of cell impracticable. The only satisfactory cells are those in which the electrodes are insoluble, thus narrowing down the types of cells to those of the lead and nickel potash iron type. In the case of the lead type, which was invented by Planté in the year 1860, the process of formation of the electrodes was as follows: Two sheets of lead were immersed in a cell containing dilute sulphuric acid, and an electric current passed for some hours through same, during which time the metallic lead at the positive pole became converted on the surface into peroxide of lead, while that at the negative took the form of spongy lead. On being disconnected from the charging source and the two poles connected externally by a wire, it was found that a current flowed in the opposite direction to that in which the charging current passed—viz., from the spongy lead to the lead peroxide externally—during which process both plates became reduced to sulphate of lead, in which condition all current ceased. By applying same to the source of supply, the plates were again converted into peroxide of lead at the positive and spongy lead at the negative, and in this condition the accumulator is what is termed charged. When fully charged, bubbles of hydrogen are seen to leave freely at the negative pole, and a red-brown chocolate colour characteristic of peroxide of lead is formed on the positive plates. The

accumulator should then be disconnected from the charging supply, and may be used for whatever purpose it is desired. As the capacity, however, of an accumulator is dependent first upon the actual area in contact with the acid, which in the case of the original Planté cell was purely the area of the positive electrode, the capacity was limited to a very great degree. When, however, the plates were treated with nitric acid, it was found that the capacity greatly increased, this being due to the fact that a very large number of interstices were developed in the surface of the lead plate, so that the plate surfaces became after the style of a sponge, the additional area being obtained by the acid permeating into the plate through these microscopically small holes on the surface, which, when added to the superficial area, greatly increased the total active surface of the plate. Unfortunately, however, when the lead plates got into this condition they became mechanically weak, as the oxides no longer have the mechanical strength of the metallic lead, with the result that the accumulator plates rapidly went to destruction. Faure at a later date introduced what is now termed the "pasted plate." In this the active material, finally taking the form of peroxide of lead, was forced into a lead grid, which was either cast or pressed, in the form of red oxide of lead, or in a further advanced stage, as far as the formation of the plate was concerned, by litharge or brown sulphate of lead. The plates were then arranged as before in the electrolyte of dilute sulphuric acid, and the current passed through same as before. The oxides of lead now became converted much more rapidly into peroxide of lead at the positive pole and spongy lead at the negative pole; and, although being weak in mechanical strength, was supported on the lead grid, which enters very little into the operation of the process. As above stated, the capacity of an accumulator depends upon the area in contact with the acid, but is also affected by the discharge current. The capacity is usually calculated in terms of ampere hours, and there is also a limit to the current which can be safely taken out of any accumulator, and is reckoned at so many amperes per square foot of active positive surface, and is roughly in the neighbour-

hood of 5 to 15 amperes per square foot of plate, according to the method of using and type of plate. This gives what is termed the maximum discharge current. The ampere-hour capacity, however, is roughly the average discharge current in amperes by the time in hours. There are other ways of reading the capacity, which, however, do not enter into this treatise.

Regarding the other form of couple—viz., the nickel-iron storage battery—which is associated with Edison and Jungner, has for its positive element iron, which is the negative pole. The negative element, corresponding to carbon of a primary cell or the peroxide of lead of a secondary cell, as previously mentioned, is a superoxide of nickel, and forms the positive pole of the battery. The electrolyte is an aqueous solution of potassium hydroxide. The voltage of discharge is approximately 1·5, but varies during the discharge. The mean voltage of full discharge is approximately 1·1 volts. The positive and negative plates, from a mechanical point of view, are alike, and so far are composed of a comparatively thin sheet of steel in the form of a grid, and the grid being filled up with the active material as stated. During the charging the current deoxidizes or reduces the iron compound of the positive plate to spongy metallic iron, and carries the oxygen through the film of the electrolyte to the nickel compound, converting it into hyperoxide of nickel, which is a higher oxide than the peroxide. This gives very roughly an idea of its action as compared with the lead accumulator. Its advantages over same are that it can be left uncharged without deterioration, which is not the case in that of the lead accumulator, wherein there is always a local action going on.

Management of Accumulators.—A few words here with reference to the management of accumulators would not be amiss, as it is an important point to always have, in the case of medical work, your accumulator in good condition and ready—as, for instance, in the case of urgent radiographic work—to be able to lift same to operate your portable X-ray apparatus. This can only be done by keeping the following points in view:

1. Battery should be kept fully charged, never allowing

it to become fully discharged; that is to say, the voltage per cell of the accumulator should never be allowed to fall as low as 1·8.

2. Never allow the accumulator to stand idle for any length of time when its charge is low.

3. Charge the battery up until what is known as the milky stage takes place—that is, when the electrolyte shows a milky appearance due to the ebullition of gas at both elements. This should be done, properly speaking, at least once a week. In a house where electric light is available this can easily be done by arranging to charge it by suitable switches through a radiator or lamps.

4. When the liquid, or electrolyte, becomes low due to evaporation, and which should have a specific gravity of 1·7 to 1·75 when charged, and never allowed to fall below 1·2, dilute acid should be added with a specific gravity of 1·8 until the electrolyte covers the tops of the plates.

5. It is important to test the voltage per cell, and not, as many do, simply take the total voltage of the accumulator. By the former method a defective or not fully charged cell is rendered obvious, and is caught in time to have it put into good condition. If the cells must stand idle for any length of time, they ought to be fully charged, and if possible given a very short charge once a fortnight.

Note.—When mixing acid, do not add water to acid but acid to water slowly, and allow to cool before putting it into cells.

6. Lastly, see that the proper polarity of the supply is connected to the cells when charging.

Fig. 134 is a simple type of what is known as a nurse's or patient's battery. The cells are arranged in series—that is, the positive pole of the first cell is attached to the negative of the second, and so on, until all the cells are included, which arrangement gives a maximum voltage, depending on the number. Thus, ten cells yield 15 volts.

Small holes are made in the front of the case, through which metal plugs pass, the one on the right connecting with the positive, and that on the left with the negative pole. One of the cords has a forked end, and with a metallic plug attached to each; this is used for increasing or diminish-

ing the number of cells in the circuit—two at a time—so as to vary the strength of the current. The chief drawback to this type of battery is that the plugs are pulled or drop out when the battery is in use sometimes, and the patients get a bit of a shock, which may upset nervous patients.

The battery can be locked by the maker, and need not be opened until exhausted or returned from hire.

A convenient size of battery is twenty-four cells, yielding 36 volts. The cells are usually 4 inches deep by $1\frac{1}{4}$ inches across, and a battery of the above strength will weigh about 20 pounds. The cells cost about 2s. 6d. at present.

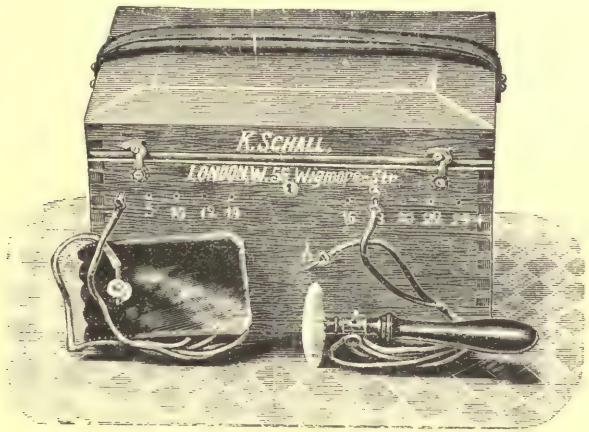


FIG. 134.—NURSE'S OR PATIENT'S BATTERY.

For a medical man a more elaborate type of battery is desirable, and we add various items, such as a cell collector, commutator, and galvanometer. Further, we may wish to make it a combined battery, galvanic and faradic, which involves the addition of a small sledge coil. Or it may be preferable to have a small Spamer battery as an aid.

Current Collectors.—These are used to increase or diminish the number of cells in circuit, thus changing the E.M.F. and regulating the strength of the current. They must be constructed so that the current is never interrupted while the number of cells is being changed, as this causes disagreeable shocks. Further, the cells must be put into the

circuit one by one, not five by five, as this will again cause shocks.

Crank Collectors are most frequently used. A number of pegs, equal to the number of cells in the battery, are arranged in a circle, so that a crank can be brought in contact with every one of them (Fig. 137). The cells are then connected in series with each other, and connected with these pegs; a wire leads from the first zinc to the negative terminal, another wire from the carbon of the first cell to peg 1, another wire from the carbon of the second cell to peg 2, etc., and one wire leads from the crank to the positive terminal. By turning the crank the number of cells connected with the terminals can thus be conveniently increased or diminished. In order to avoid inter-

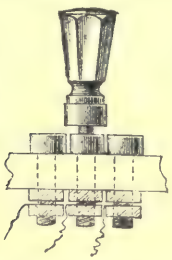


FIG. 135.—CRANK RIGHTLY PLACED.

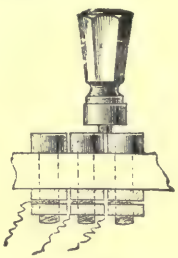


FIG. 136.—CRANK WRONGLY PLACED.

rupting the current, the pegs are so arranged that the crank touches the next peg before having quite left the former one.

As long, however, as the crank touches two pegs—for instance, pegs 5 and 6 (Fig. 137)—at the same time, the sixth cell is short-circuited, for the current can pass from the zinc of cell 6, which is connected with the carbon of cell 5, on to peg 5, through the crank of peg 6, and from thence back to the carbon of cell 6, without finding on its way any resistance worth mentioning. If this state of affairs lasts but a very short time it causes no damage, but if it continue, the short-circuited cell will be exhausted. It is therefore important with all crank collectors to let the crank rest as in Fig. 135, and not as in Fig. 136, where it is in contact with two cells at once.

The number next to the peg on which the crank rests

shows the number of cells in action. This kind of collector is convenient, but it has one drawback, especially if used with batteries containing a large number of cells—viz., that by being put in the circuit the first cells of the batteries are exhausted more quickly than the last ones.

Double Collector.—This is designed to obviate the above difficulty, and has two cranks, which are placed on the same axis, but are insulated from one another; the zinc of the first cell is not connected with a terminal, but with an additional peg, 0. One crank is connected with the positive

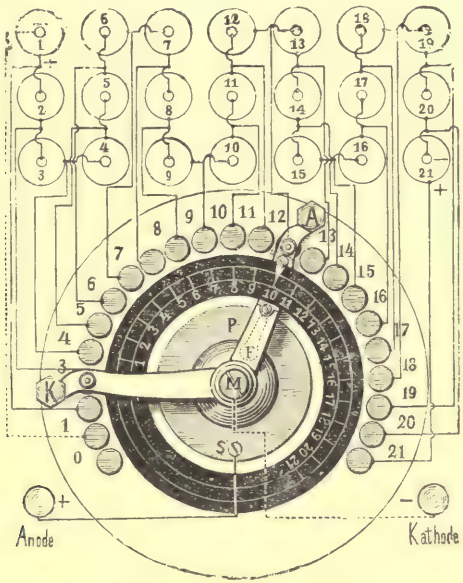


FIG. 137.—DOUBLE CRANK COLLECTOR.

and the other with the negative terminal. By these two cranks any batch of cells may be inserted, and the whole battery used up evenly. An index fitted to one of the cranks points to a division, thus showing the number of cells in action.

Finally, each single cell can be connected with a galvanometer and tested, so that damaged or exhausted cells may be detected without trouble. The double collector is thus a great convenience in testing a battery, and is certainly the best collector known at the present time.

The Medical Battery.—The above is a fairly common type of battery suitable for a doctor. The cells—from twenty-four to forty-eight—are arranged in a suitable box of oak or mahogany, coupled in series, with double-current collector, commutator, and galvanometer. It is a continuous-current battery as opposed to what is called a combined battery, which includes an induction coil. The fittings are usually fastened to a sheet of vulcanite or of wood similar to that forming the box. An explanatory word may be

Fig. 138.—Combined Battery with Single Collector.

needed about cells being coupled in series. In this way we get the maximum E.M.F. with a small amperage. The negative of the first cell is joined to the positive of the next, and so on. The unconnected zinc and carbon form the two poles.

As we know, the voltage of the average Leclanché cell is 1·5 if in good order. If a number are connected in series, then the voltage is the sum of the voltage of the separate cells. We have a large internal resistance proportional to

the number of cells in the series, but are able to overcome the large external resistance which the human body always affords; therefore for electro-therapeutic purposes we always have cells coupled in series.

If we couple cells in parallel—that is, connecting all the positives and all the negatives together—the internal resistance is inversely proportionate to the number of cells: we have a low voltage, but a high amperage or heavy current. Practically the only case in which we use this arrangement is for electro-cautery, and even then the individual cells should be of large capacity and of equal voltage, otherwise currents will circulate between the cells and destroy them.

Electrodes.

The various instrument makers see to it that there is every shape and variety of these on the market. They are of two main types—the handled electrodes and the plate

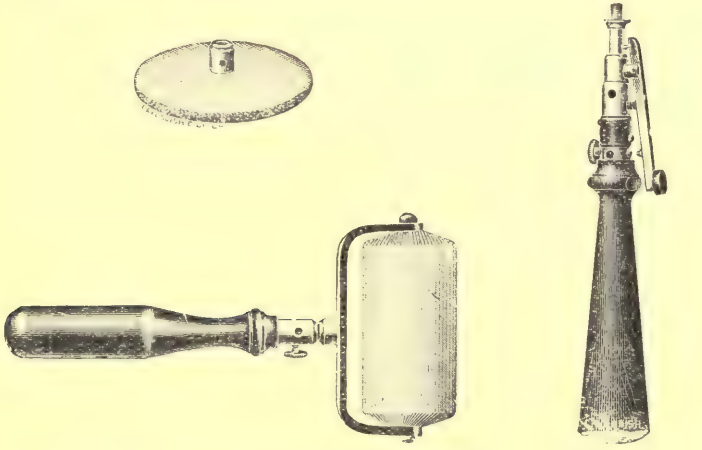


Fig. 139.—Button and Roller Electrodes; and Make and Break Handle.

variety of various sizes. Handles of oak or mahogany are fitted, and at the base is a hole with a retaining screw, through which the wire at the end of the conducting cord

is attached. Various sizes of button electrodes can be screwed on up to 1½ inches or 2 inches square.

The active surface of the metal of the electrode is covered with chamois leather, which must be of even thickness and free from holes. In place of the plate a roller end is some-

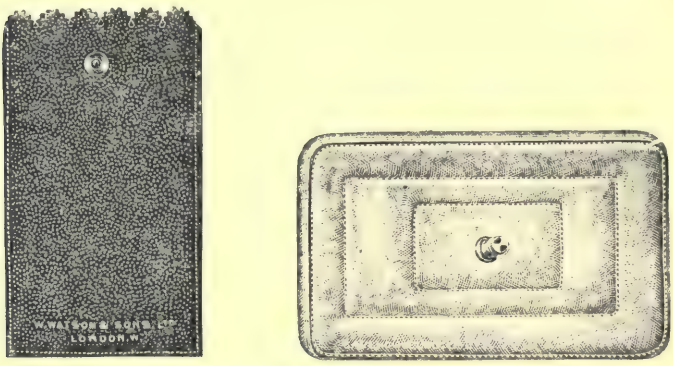


FIG. 140.—INDIFFERENT ELECTRODES.

times provided, which is of special use in the labile method and electrical massage. Sometimes a means of making and breaking the current is added to the handle, but it is pre-

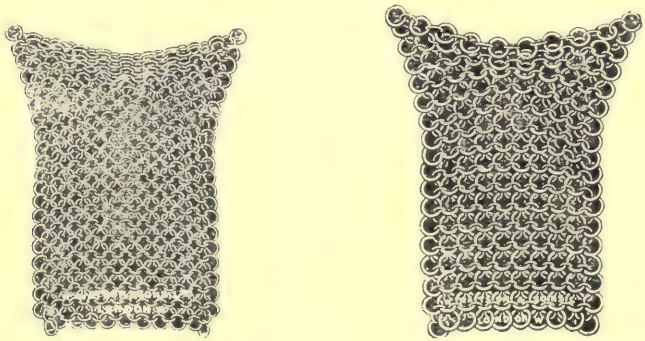


FIG. 141.—CHAIN MAIL ELECTRODES.

ferable to effect this at the battery or on the switchboard by means of a commutator.

Plate electrodes are made of zinc or white metal cut into various sizes and shapes, with a retaining screw preferably

at one extremity, to which the connecting cord is fastened. This should not be put in the middle of the surface, as if the patient has to lie on the electrode it becomes very uncomfortable after a while. *Chain mail* electrodes have been used for ionization, but are not to be specially recommended, as they are apt to break up easily.

Considerable care is needful as regards the connecting cords. Those sold with most of the cheaper batteries are so flimsy as to be almost useless. The tinsel thread very soon breaks, and gives rise to shocks and much waste of time investigating why the current is not passing properly.

One of the best ways of making satisfactory connecting cords is to utilize ordinary electric bell wire which is covered with rubber and a layer of waxed thread. Suitable lengths of this can be cut, and the special pin or wire end for attach-

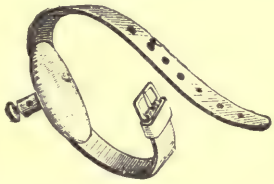


Fig. 142.—Wristlet Electrode for Electric Massage.

ment to the binding crew can be dispensed with. They do not always fit the hole, and a break in the circuit sometimes occurs just where the pin joins the cord. This trouble is avoided if we use the bell wire and simply scrape the insulating covering off the end of the cord with a blunt knife, leaving about an inch of the copper centre bare. This can be passed through the hole of the electrode, or if the screw fastener is of the telegraph type, as sometimes happens, it can then be looped around it. Details such as these may seem trivial, but save an immense amount of time in practical work if attended to carefully.

Tests for Polarity.—All properly constructed electric batteries and switchboards are marked by the maker so as to indicate the sign of the electrode, one binding screw being negative and the other positive. It may be desirable, however, from time to time to test the poles, and this is

an easy matter. This may be done by connecting two wires to the binding screws of the battery or board, and dipping them into a tumbler of water with the ends ½ inch apart. The negative end gives off a lot of bubbles, due to the liberation of hydrogen. Alternatively pole-finding paper may be used, and when applied moistened the negative pole turns red. The ordinary litmus-paper used for urine testing may be used also, blue litmus turning pink at the positive pole. A battery never changes as regards its

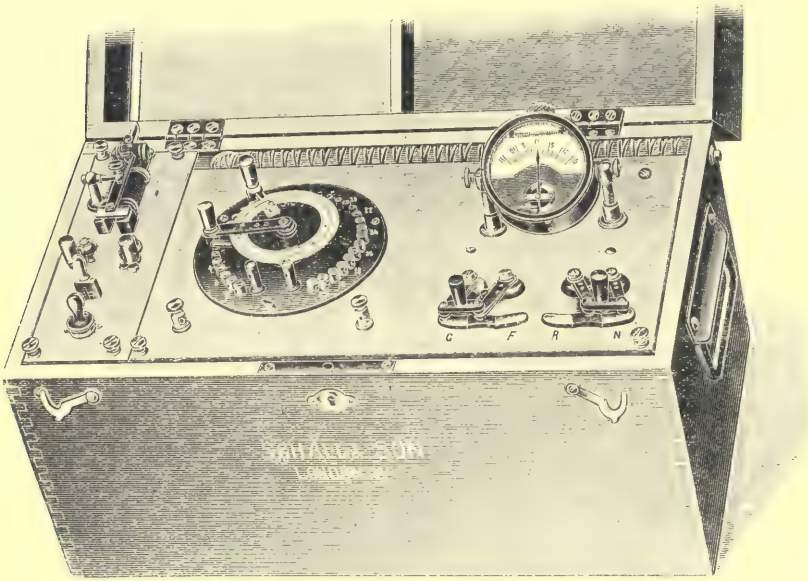


FIG. 143.—NEAT TYPE OF COMBINED BATTERY WITH DOUBLE COLLECTOR.

polarity unless by accident during recharging or repairing, but with switchboards on town supplies it is different, and the mere turning around of the wall plug is all that is necessary to give rise to reversal.

Effects of Galvanism on the Skin.—The action of the two poles varies. If we take two electrodes about 1 inch in diameter, and, placing them on the skin about 2 inches apart, pass a current of 2 to 3 milliamperes, it is noticed that the sensation at the negative pole is more marked and

may even be painful. If the current is kept up for an hour or more, we may even cause an ulcer, especially if there is any unevenness in the surface of the electrode. Bare metals should never be allowed to touch the skin; they must be covered with chamois leather of uniform thickness. If the leather gets worn at any point and the metal works its way through, a painful sore, very slow to heal, is caused. This is due to the whole of the current for the time becoming focussed on the spot covered by bare metal, giving rise to a very high current density at this spot. We have known this to occur through the attendant's carelessness, and the patient having the idea that he or she should be prepared to submit to a reasonable amount of discomfort. Indeed, the patient's sensations are not really a sufficient guide to what is occurring. When a current of 3 milliamperes or more is passed for five minutes or over, a periodic inspection is desirable to see the electrodes are moist and that they are evenly applied, and note taken if there is any suggestion of redness and blistering. This is always most likely to take place at the negative electrode.

Greater safety is secured by placing a layer of lint or cotton-wool below the electrode, though it is already covered with wash-leather or flannel. The leather should be moistened with hot water, and the addition of baking soda materially increases the conduction.

A fall in the amount of current passing, as shown by the galvanometer, is a sign of commencing electrolysis of the skin, especially if accompanied by a burning sensation of the skin under the pad. Fresh water must be applied to the electrodes so as to improve the conduction.

The amount of sensation always largely depends on the area of the electrode, and this brings us to the subject of the density of the current at any point.

Density of the Current.—The size of the electrodes is of considerable importance. The larger the electrode, the smaller the resistance of the human body. Electrodes of 10 square inches surface will pass through the body twice the current that can be conveyed by 5 square inches under otherwise equal conditions. This leads us to the density

of the current, or, in other words, the proportion of the strength of current to the sectional area of the conductor. If, for instance, with electrodes of 3 square inches surface 20 milliamperes are passing through the body, the current is three times as dense as if electrodes of 9 square inches and the same strength of current were used. In other words, in the first case each square inch of the places of application receives 6·6 milliamperes, whereas in the second case only 2·2 milliamperes are received by the same area. The physiological and chemical effects would in the first case be three times as strong at and near the point to which we apply the electrode as in the second case. Statements that such and such results have been obtained with so many milliamperes are therefore incomplete unless the area of the electrodes used and the time of application, are mentioned as well. On entering the body the current divides itself into numerous loops and branches, and follows the best conducting parts till it reaches the other electrode. The density is greatest where the two electrodes touch the body; it is a little less near the straight line connecting the two electrodes, and smallest in those parts of the body which are most distant from the electrodes; but experiment shows that even those parts are reached by some small part of the current.

Failure of a Battery to Work.—When a battery does not work the problem facing one at once is, Where does the fault lie: is it in the cells, the terminals, cords, or handles? Five times out of six it will be in the connecting cords. In all batteries of any strength, when the two bare ends of connecting cords are momentarily brought into contact and separated again, a spark will be seen. If this is not seen, then test each cord by fastening it to a terminal and touching the other terminal with the end. If still no spark be seen, touch the first peg with one end of the cord, and with the other end touch the last peg of the collector. If still there be no spark visible, test the cells in groups of five, either with the pegs on the current collector, or by touching the terminals. In this way faulty cells or weak groups of cells may be singled out. Difficulty may arise from screws on the cells working loose in transit, and a

general overlook now and then is always a precaution against trouble of this character.

Much trouble was caused in the old days by using wet cells, which occasionally cracked, the contained corrosive fluid escaping. With dry cells, all separate, any individual weak element may be removed and replaced from spare stock. Reference to the maker is thus avoided and time saved.

A galvanometer may be called into requisition and cells tested one by one. If the battery is a small one, not more than ten cells, one can detect the absence of current by touching the tongue with the terminals. If the cell be working, a peculiar taste is at once noticed.

Faults rarely occur between the cells and current-collectors, as the wires are well protected and the invisible connections soldered. At times the pegs of the collector and the current reverser become oxidized, and need a clean up with fine emery paper. Dust between the studs of the collector requires removal with a fine hair brush.

The screws holding the cranks of the current collector in their place may need tightening at times. Care must be taken never to put cords or handles or wet electrodes on the collector, as they may cause a short circuit, destroying the cells.

Faradism.

Faradic currents are those produced from induction coils, and are probably the most frequently employed of all electro-medical methods, especially by the only partially trained, as their manipulation is simple and comparatively free from risk; owing to the sharp contraction of muscles treated also, the patient feels satisfied that he is getting "value for his money."

The main use of currents of this character is really to excite and give exercise to sluggish or feeble muscles, striped or unstriped, stimulating them through their nerves of supply and so increasing their nutrition.

It is an excellent adjunct to massage, and makes the treatment more interesting to patients than is plain massage. Some physicians have, however, a very poor opinion of the

therapeutic value of this current. A well-known neurologist once informed the writer he looked upon it as little more than a diagnostic agent for investigating reaction of degeneration, and so forth. This is a hard saying. But it is to be feared that the busy little battery of the Spamer type, cheap to buy and easy to run, does lend itself materially to a certain amount of lay quackery, and to people "trying electricity" where there is no chance of a good result.

Speaking from personal experience, there is no doubt but that the faradic current is of therapeutic worth.

The actual current may be derived from a small coil with one or more dry Leclanché cells, or from a switchboard, or from one of the universal apparatus, such as the multostat. There is much in favour of a sledge coil worked from a dry-cell battery or from a wall plug on the town supply. This is really an ordinary Du Bois Raymond coil, the primary coil having 200 to 300 turns of wire, and the secondary many more. The primary wire is usually insulated copper wire, No. 22 B.W.G. The E.M.F. of the primary coil is between 5 and 30 volts, according to whether the core is pushed home or not. Indeed, on this core depends very much our means of varying the current strength, as the faradimeter is rather a laboratory than clinical apparatus.

The Induction Coil.

The modern induction coil or sledge coil, of which the above is a scheme, is a modification of the Du Bois Raymond coil. In Fig. 144 *D* represents the battery or the main; *a* the wire from the positive pole, and *g* that from the negative; *S* is a brass upright; *F* the spring supporting the armature or the Neef (or Wagner) hammer; *b* the contact screw; *c* the wire forming the primary helix (*xx*) containing the soft iron core; *KK* the secondary winding or helix, with board (*pp*) on which it can be moved; *H* soft iron core magnetized by the current when passing around it.

When the current in this is closed, the horse-shoe *H* becomes magnetized and attracts the armature or Wagner

hammer *e*, breaking the contact with the screw *b* in doing so. The current is then broken, and the horse-shoe promptly becomes demagnetized; the armature *e* being liberated springs back, by aid of the spring *f*, to its original position on contact screw *b*, thus re-establishing the current. *H* becomes remagnetized, and the whole process is repeated quickly *ad infinitum*.

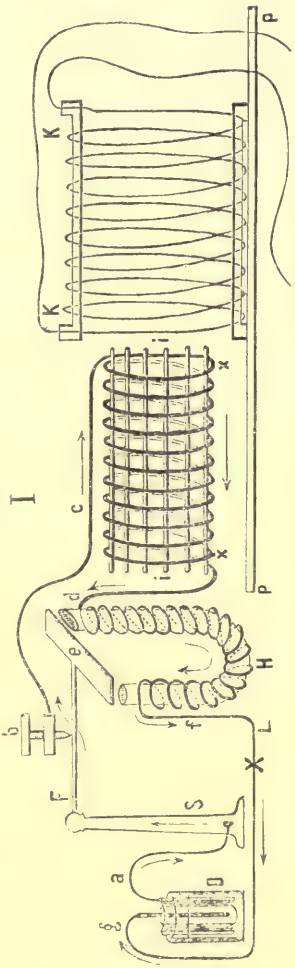


Fig. 144.—Diagrammatic Representation of Induction Coil.

We obtain the faradic current from what is known as an induction coil, and the principle upon which it operates is that of electro-magnetic induction. The principal parts of same are the interrupter, the primary circuit, and the secondary circuit. In Fig. 144 will be found an illustration showing the general arrangement of the various parts of a modern instrument, such, for example, as a Du Bois Raymond coil. In same *D* represents the battery or main supply, *A* the wire from the positive pole, *S* that from the negative pole. *S* is a brass upright supporting *F*, the spring carrying an armature of soft iron, *e*; *B* an adjustable screw with a platinum contact piece which presses against a corresponding platinum piece on the spring *F*; *C* the wire forming the primary coil, in the axis of which is a core, *I*, of a bundle of soft iron wires. *H* is a piece of soft iron in the form of a horse-shoe, round the poles of which is wound a coil of wire. *K* is the secondary coil, which is mounted on a base permitting to be slid at will over the primary

coil. *L* is a switch whereby the circuit is closed when it is desired to operate same. On closing the switch *L*, the current flows from *a* through *S* to *F*; there by the platinum contacts to contact screw *b*; from there through the primary coil *C* to horse-shoe with coil *H*; finally through switch *L* to negative pole of battery. As the current passes through coil *H* of horse-shoe, the soft iron is converted into a temporary magnet, which lasts as long as the current lasts, and attracts the soft iron armature *e*, which causes the spring *F* to leave the contact screw at the platinum points,

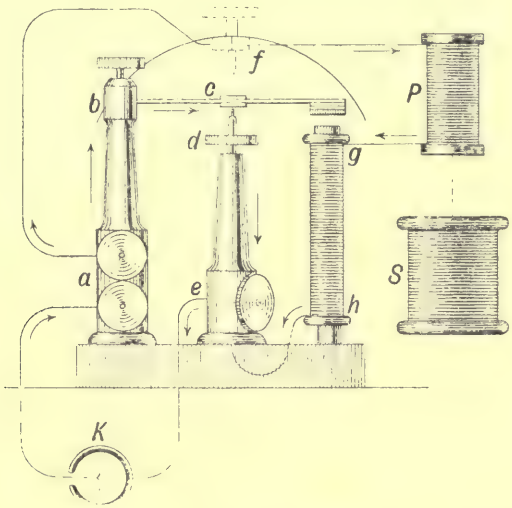


FIG. 145.—DIAGRAM OF NEEF'S HAMMER AND INTERRUPTER.

thus breaking the electric circuit and causing the horse-shoe to lose its magnetism, with the result that the armature *e* is released from the magnetic grip and returned by spring *F* to its original position in contact with screw *b*, which immediately gives rise to a similar cycle of operation by again closing the circuit and exciting the horse-shoe magnet, which in turn again attracts the armature *e*, and so on. The number of times this cycle is repeated per minute depends on the strength of the current, the mass of the armature, and the strength of the spring *F* and position of contact screw *b*, and is known as the number of inter-

ruptions of the primary current per minute. The above description refers to the action of the interrupter, whose main function is to give rise to a variation in the strength of the magnetic field enclosing the primary coil, and which in turn can also be made to enclose more or less entirely the secondary coil by sliding same over the primary.

At the present time there are many different forms of interrupters, but the foregoing description holds good for practically all. The main difference lies in the fact that with the cheaper coils the spring *F* with this armature is sometimes actuated by the magnetism forming part of the primary winding of the coil. This, however, has many disadvantages, and among them a very limited amount of control of the rate of interruption. That shown in Fig. 145 is a very good type, and is, as a rule, attached to the best types of coils. The contact spring in this case is replaced by a solid brass bar which carries the hammer, and is pivoted on a fulcrum with a helical spring, the tension of which can be controlled by a small thumb-screw, *R*. The electro-magnetic in this case is separate and made up as described in the beginning of this section. In addition to the screw *R* for varying the tension, there is a small screw, *J*, mounted on the lever carrying the hammer, its function being to modify the growth of the magnetic field, otherwise the wave-form of the make and break induced E.M.F. in the primary and secondary. There is also a sliding knob, *K*, which can be moved up and down an aluminium angle piece which is attached to the armature, as shown in the illustration, when it is desired to make the rate of interruption very slow. In other words, it simply adds to the total mass of the armature, and varies the oscillating period of same. A very fine adjustment, also, is obtained by varying the position of *K* on the upright part. By this means interruptions can be made as low as sixty per minute, and even less. If the natural period of the oscillating system is small, and likewise that of the time-rise of the current, then the rate of interruption will be very high, and under these conditions anæsthesia can even be produced. This, however, requires, generally speaking, a special form

of interrupter whereby this object is attained, and will be described later.

Origin of Induced Currents.—If the two ends of a wire are connected with a sensitive galvanometer, and a magnet brought near the wire, the needle of the galvanometer declines *so long as the magnet is approaching,* and returns to zero if the interval between wire and magnet is allowed to remain constant.

If the magnet be withdrawn, the needle declines again, but in the opposite direction. If in the neighbourhood of the closed conductor a second wire is drawn parallel to the first, and this second wire is connected with a galvanic cell, the needle deflects the moment the circuit is closed, although there is no connection whatever between the two wires; but it returns to zero immediately afterwards, and remains there, although the galvanic current continues to circulate in the second wire. If we diminish or interrupt

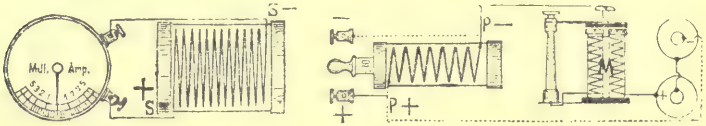


FIG. 146.—DIAGRAM ILLUSTRATIVE OF INDUCED CURRENTS.

the current, the needle deflects again, but in the opposite direction, thus showing that the approaching and withdrawing of the magnet—or the making and breaking of the current in the conductor close by—induces currents in the closed circuit, which are, however, of very short duration and pass in the opposite direction.

The currents induced by a closing current then pass in the opposite direction to the inducing current, and those induced by breaking the first inducing current pass in the same direction as it does. If, therefore, we make and break the inducing current very often consecutively, we induce each time a momentary current in another conductor; but the direction of these induced currents keeps changing, and they are therefore called alternating currents in contradistinction to those which keep their polarity.

Self-Induction—Extra Currents.—The wire through which the inducing current passes is called the primary wire, and

the wire in which currents are induced is called the secondary; the induced current is called the secondary current. For various reasons the primary and secondary wires are not drawn in a straight line, but are wound in spirals on cylinders of wood, paper, etc., which are made of such sizes that the primary coil can be pushed into the secondary coil. In a spiral, each turn of the wire is parallel with the previous and following turns of the same spiral; and a current which passes through a turn of the spiral must therefore have an inducing influence on the other turns close by. This effect of the different turns of the same spiral on each other is called *self-induction*, and the current thus induced is called *the extra current.* If the current is made, the extra current, too, has an opposite direction to the inducing current, and thereby retards and weakens it, and, consequently, the secondary also; but if the inducing current is interrupted, the extra current flows in the same direction as the inducing current, and thereby increases the latter considerably, and the secondary current as well. The shocks induced by making and breaking the inducing current are, therefore, of very unequal strength; those made by breaking the inducing current predominate very much, and the signs + and −, which are marked on the terminals of the better induction coils, are intended to show the direction of the currents induced by breaking the inducing current. The signs would have no meaning if the currents resulting from making and breaking the inducing current had an equal strength, as they follow one another in opposite directions.

Primary Currents.—If we connect one or two galvanic cells with a Wagner's hammer, which is provided with a small electro-magnet only, and connect the cells by two further wires with two electrodes which we hold in our hands, we shall not feel the making or breaking of the current. But if the current has to pass a primary coil with several hundred turns of wire besides the Wagner's hammer, each breaking of the current gives us a decided shock, the strength of which, amongst other things, depends upon the number of turns of the coil, and varies with the extra current. This is the primary current which we

obtain from medical induction apparatus; it is an intermittent galvanic current, very considerably increased by the extra current, but it is not alternating. The inducing effect of a current is considerably increased by letting it act simultaneously with a magnet, and this can be arranged easily if the primary wire is wound round *an iron core*, or, better, if it is wound round a cylinder into which an iron core can be pushed. It is, however, preferable that the core should consist of a bundle of soft iron wires, as these take and lose magnetism much more quickly than solid iron.

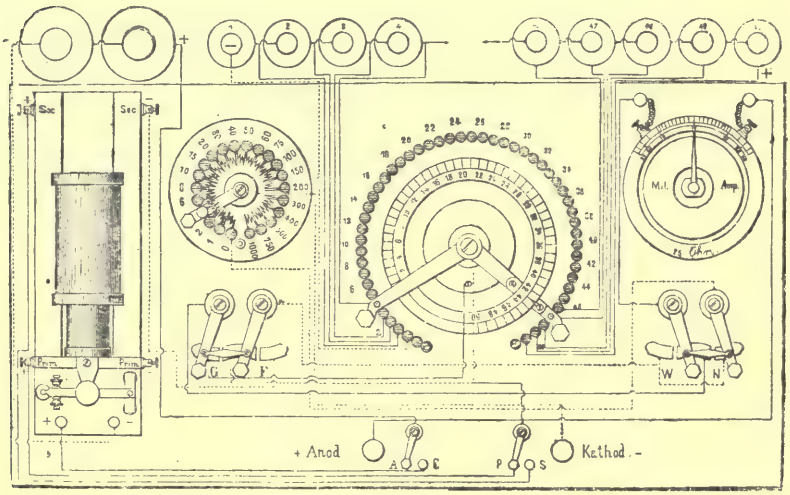


FIG. 147.—SCHEME OF GALVANO-FARADIC BATTERY, WITH SLEDGE COIL, DOUBLE COLLECTOR, CURRENT REVERSER, GALVANOMETER, AND CELL CONNECTIONS SHOWN.

The Electro-motive Force of the induced current depends—(1) On the number of turns of wire which a coil has: the more turns the higher the E.M.F.; (2) on the strength of the inducing currents: the stronger the latter, the higher the E.M.F. of the induced currents; (3) on the presence or absence of soft iron core: its presence increases the E.M.F. of the induced current very materially; (4) on the suddenness of the break of the inducing current. Ultimately the E.M.F. of the secondary current depends on the distance between the secondary and primary coils; the closer

they are together, the higher is the E.M.F., and *vice versa*.

Strength of the Induced Current.—This is dependent, again, on Ohm's law that the current is equal to the E.M.F. divided by the resistance. If the induced current be 70 volts and the resistance of the secondary coil 610 ohms, and that of the patient 2,300, then the strength of the current would be:

$$\frac{70}{610+2{,}300}=0{\cdot}024 \text{ ampere, or } 24 \text{ milliamperes.}$$

The strength of the induced current cannot be measured by an ordinary galvanometer, since the secondary currents are alternating, and would be at one moment causing a deflection of the needle to the right and at another to the left.

Some galvanometers which are made without a permanent magnet may be used, but the chief obstacle is that the currents are intermittent, and since each impulse lasts a very short time only, the galvanometer remains without a current until the second impulse occurs.

The indication given by the galvanometer will vary directly with the number of interruptions, showing much more current with thirty breaks than with five breaks per second, although the actual current strength remains constant. The only possible way to measure currents of faradic coils is by their E.M.F. (see below).

The chemical action of faradic currents is but small, chiefly on account of their short duration, but also because they are alternating, so that each following impulse in the secondary partially neutralizes its predecessor. This in no way detracts from the mechanical effect on nerve and muscle, which is intense. Muscles contract sharply when the contact is made with the electrode, and even more sharply when it is broken.

Differences in the Effects produced by Primary and Secondary Currents.—The physiological effects produced by the use of secondary currents depend on the strength of the inducing current, the quality of iron in the core of

the primary, the number of interruptions per second, and the ratio of the number of turns of the primary to those of the secondary.

If all conditions are the same, with the exception of the ratio of the primary to the turns of the secondary, then the physiological effects produced vary with the voltage and the current; the greater the number of turns, the higher the voltage produced. A great number of turns causes prickly pain locally, but not strong muscular contractions. If we decrease the number of turns and reduce the resistance by increasing the sectional area of the wire, the local pain effect diminishes and there are powerful contractions of the muscles to be observed. These latter currents are largely used for treating deeply seated organs, the former type for treating nerves and other parts lying near the surface of the skin.

The effects produced by the primary current are similar to those produced by the secondary with a corresponding number of turns. It is possible to regulate the current better by a movable secondary of equal turns to the primary than by moving the iron core out or in; the movable secondary is specially recommended in electric bath treatment.

Regulation of the Primary Currents.—The E.M.F. of the primary current can be regulated in different ways; for instance, by inserting a larger or smaller number of turns of wire by means of a crank, etc. The simplest and almost only practical method, however, is to regulate the E.M.F. by pushing the iron core in and out. The primary current is weakest if the iron core is drawn out, and becomes stronger as it is pushed in. Instead of drawing the iron core out, a damper in the shape of a brass or copper tube can be slipped over it with the same effect. If the iron core is entirely covered with the tube its inducing power ceases, but the E.M.F. increases the more the brass tube is withdrawn. The position of the secondary coil has no influence on the strength of the primary current.

Regulation of the Secondary Current.—The secondary coil is generally constructed with a large number of turns

of wire—about 2,000 to 6,000—for in most cases it is desired to obtain a high E.M.F. The wire used is generally thin copper, about No. 36 B.W.G. The resistance of the secondary coil varies under these circumstances between 100 and 900 ohms, and the E.M.F. between 10 and 200 volts. The strength of the secondary current can be regulated in different ways. If the apparatus has a small primary coil, it is sufficient for all purposes of treatment to regulate the strength of the secondary current by merely pushing the iron core in and out, for a current which is hardly to be felt when the iron core is drawn out can be increased quite gradually to painful strength by pushing it home. The more complete coils, however, are so arranged that the distance between the primary and secondary coil can be

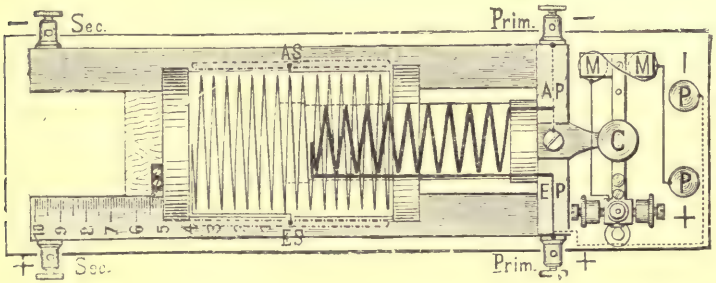


FIG. 148.—DIAGRAM ILLUSTRATING THE REGULATION OF THE SECONDARY CURRENT.

easily changed (see Fig. 148). In this case the secondary coil slides on a sledge, and can be pushed over the primary or be drawn away from it, an arrangement which allows an exceedingly fine regulation of the current. These sledge coils, which were first suggested by Du Bois Raymond, are decidedly preferable to any others for diagnostic and physiological purposes. The strength of current in this apparatus can be further regulated by pushing the iron core in and out (Fig. 149). The secondary current might also be regulated by means of a crank which inserts more or less turns of wire, but this does not allow of as fine graduation as the moving of the iron core or the coils; or it might be regulated by rheostats, but this is not very practicable,

and is seldom employed, as high resistances would be required.

The Regulation and Measurement of the Current Strength.—Some means of regulating, to a greater or less degree, the strength of the current is necessary.

The following are the methods commonly employed:

1. The strength of the magnetic field is varied by the use of a sliding core, as shown in Fig. 149. A small auxiliary electro-magnet is employed to work the interrupter. The current is a somewhat irregular one of low frequency. The

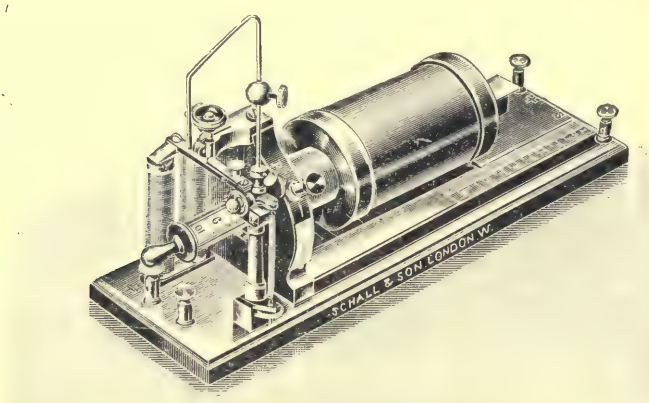


Fig. 149.—Du Bois Raymond's Coil, with Adjustable Interrupter and Sliding Core for regulating Current Strength.

interruptions are rather unpleasant to the patient, and such instruments are ill-adapted for delicate electrical testing.

2. A movable secondary coil is used, which can be brought into weaker or stronger parts of the magnetic field of the instrument. This method gives a wide range of current strength, but is only suitable for regulating the secondary current.

3. The iron core of the primary coil may be covered by means of a metal tube which slides over it and shields the coils from its magnetic action.

4. The current strength may be varied by means of interposed resistance in the exciting or secondary circuit.

5. A switch may be used which brings into action a greater or less number of the windings of the secondary coil.

The Measurement of Faradic Currents.—As previously stated, the faradimeter of Sloan is rather a laboratory toy than a therapeutic aid. Galvanometers are of little more use, for two reasons. Many of them which are capable of measuring an alternating current, such as the "hot wire" type of galvanometer, are not sufficiently sensitive to measure a few milliamperes only. But more important than this is the fact that galvanometers cannot be used

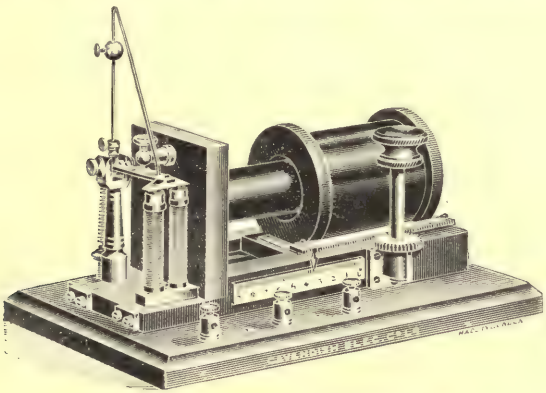


FIG. 150.—APPARATUS FOR FARADIZATION.

unless all the interrupters of the coil the current of which is to be measured vibrate at a uniform and fairly rapid rate.

Since a galvanometer will register less if there be only five interruptions per second than if there are twenty or more —current being constant—the difficulty is plain.

Various workers have shown that currents of a very short duration and a certain E.M.F. give the same physiological effects, whether they are produced by an induction coil, a galvanic battery, or a condenser discharge. A coil was therefore constructed in which the scale was graduated in volts; the readings of the scale are correct as long as there is a primary current of exactly 0·3 ampere. Further condensers were constructed of one microfarad capacity, which could be charged from a battery and discharged

through the patient in rapid succession by a key working like the interrupter of a coil. If the number of volts used for charging the condenser is known, the current can be measured, and the results compared, just as the number of milliamperes with a continuous current.

The use of a continuous current with an interrupter worked by an electric motor has been suggested for testing the reaction of muscles, and for treatment with the interrupted current. The interrupter or reverser is fixed on the axis of the motor; it is in the circuit of a galvanic battery (or the current from the main), and a milliamperemeter is also in the circuit. By means of the latter the current flowing through the patient can be measured while the interrupter is at rest; when it is started, the galvanometer will indicate less, and the difference between the two readings can be used to find out the duration of the current. If the galvanometer indicates, for instance, one-fifth of its former reading, it shows that the current is closed for one-fifth and "off" for four-fifths of the time of a period or revolution. The proportion between the time it is "on" to the time "off" can easily be varied and adjusted by altering the position of one of the two brushes.

It has been proved that more powerful contractions of muscles, with less pain, are obtained with short contacts and long intervals with no current—*i.e.*, if the brushes are so adjusted that the time during which the current is closed is only about one-tenth of that during which the current is "off." The number of interruptions per minute can be adjusted by means of a rheostat controlling the speed of the motor, and can be read off a speed-counter. The E.M.F. used can be regulated by increasing or diminishing the number of cells or amount of current in the circuit.

We have dealt fully with the whole theory of induction and the coil based on Faraday's work, without which it is impossible to have a clear grasp of the method of working of a faradic battery.

Having done this, we can now treat with the actual apparatus. There are two main types of faradic battery in use: first, the small self-contained and portable Spamer type, costing about 30s., with a dry cell or, better, two;

and the Lewis Jones sledge coil with a separate battery. The latter is best operated from a plug in a lamp socket on the direct current main, and is very handy when giving massage in a ward of a hospital or patient's room. It is more adapted for taking from house to house, and can be conveniently contained in an ordinary doctor's or nurse's hand-bag.

From the main we may use as an intermediary the galvanoset with a faradic attachment, the faradiset, or one of the various types of switchboard or universal apparatus.

All types of batteries and switchboards are provided either with separate primary and secondary terminals or with a switch, which is the better arrangement. The respective uses of these two currents have been dealt with above.

Electrodes.—There is little to say about these more than has been said under galvanism. They are, for all intents and purposes, identical. The roller electrode has some advantage if general faradization be called for. This is used much as is general massage, and the whole body brought under the influence of the faradic current. Nerves are stimulated, muscles thrown into contraction, etc. The metabolism is improved along with the circulation and general body nutrition. A weak current is at first employed, or the patient may acquire an early dislike to the treatment difficult to remove.

The electrodes are referred to as indifferent and active.

The indifferent electrode is usually a large, oblong, flat plate of white metal, on which the patient lies, care being taken that contact is maintained, the sacrum being a good region to apply it.

The active electrode is always smaller, and usually a disc or roller, as referred to previously.

It is very convenient to apply the current, however, through a masseur's hands, the operator wearing a little wristlet electrode with a spring which grasps his wrist. Many patients prefer this method, especially those who are accustomed to massage.

Failure to Work.—If an induction coil fails to work, it should be first seen if the connection with the main is faulty, if the fuse has burnt out, or if the cell element is exhausted

where one is in use. If the source of supply is not defective, then the interrupter must be investigated. This is the most delicate part of the induction coil, and therefore care is necessary not to interfere with the contact screw if it is not strictly necessary, for very often apparatus which were in quite good order have been spoiled by playing with this screw. The interrupter does not always start of its own accord, and has to be put in vibration by being slightly touched with the finger. The hammer should be arranged so that its distance from the electro-magnet is about $\frac{1}{16}$ part of an inch, and the platinum point of the contact screw should just touch it. Those apparatus in which the hammer is fastened to a rigid bar, as in all sledge coils, are less liable to get out of order and to require readjustment than coils the hammer of which is attached to a watch-spring. The interruptions of these latter apparatus are also frequently less regular. If an interrupter has not the proper distance from the electro-magnet, it has to be carefully bent till it keeps the correct distance. The spark on the interrupter attracts dust, and the little platinum sheet should be cleaned occasionally with fine emery paper. Oil should on no account be allowed on the interrupter.

If the apparatus still fails, although cell and interrupter are right, see whether the connecting cords are in order. To try an apparatus by touching the terminals or the connecting cords with two fingers is useless. It can only be tested with well-soaked and properly connected electrodes. The coil and the connections are very well protected, and can be damaged only by spilling a good deal of acid; the connections become oxidized in such a case, or the wires may even be eaten through. An apparatus damaged in this way has to be sent back to the manufacturer for repair.

The Electrical Examination of the Muscles and Nerves.

By this procedure in neurology the physician derives the most important information in differentiating between an upper and lower neuron lesion, and in estimating the degree of degeneration which has taken place either in the nerve or muscle which it supplies.

We require at least what is called a combined battery, or preferably a galvanoset or switchboard with sledge coil, and further use two conducting wires and three different electrodes—one large, about 6 by 4 inches, a medium size round one, and a small disc about 1 inch diameter. The two smaller electrodes have handles; some people work with an interrupting handle, but it is better to work with a switch or commutator on the board for turning on and off the current. There is thus less chance of making mistakes in small movements occasioned by taking the electrode away and putting it back again on the part being examined.

If we proceed to test the faradic reaction first, the large indifferent electrode is placed on some part, such as the back of the patient's neck, or face up on a table while the patient presses his hands on it. The small electrode, the effect of which we have to observe, is then moved over the various motor points of the muscles to be tested. Alternatively, the person carrying out the examination may put himself into the circuit by holding the small electrode in his hand, or by means of a wristlet, and then touch the various points with his finger, previously moistened.

A knowledge of the motor points is a help, but not essential, as charts are easily obtainable, and much may be learned of the condition by passing the small electrode or finger up and down the muscles more or less at random.

The motor point of a muscle is usually near the point of entry of the nerve into the muscle, while that of the nerve is near its most superficial part. The electrodes and skin should be always thoroughly moistened with warm water, and soaping the surface of the electrode which is moved about is of service. Salt is unnecessary, and eventually leads to corrosion.

The patient should be placed in a good light, where both sides of the body can be observed equally. First observe what amount of current is needed to produce a contraction of the healthy side, and then test the side suspected of disease with the same amount. See if there is any contraction, and if not note the amount of current required to produce one.

The faradic contraction of a muscle can be only obtained

through the nerve of supply, whether the muscle be healthy or the reverse.

If the nerve is damaged or diseased, then the response will be proportionately feeble, or there may be a total loss of faradic reaction. A diminution of faradic response indicates some disease of the lower motor neuron.

In testing with galvanism, we have to estimate both the quantitative and the qualitative changes. The galvanometer must be studied to note the minimal amount of current required.

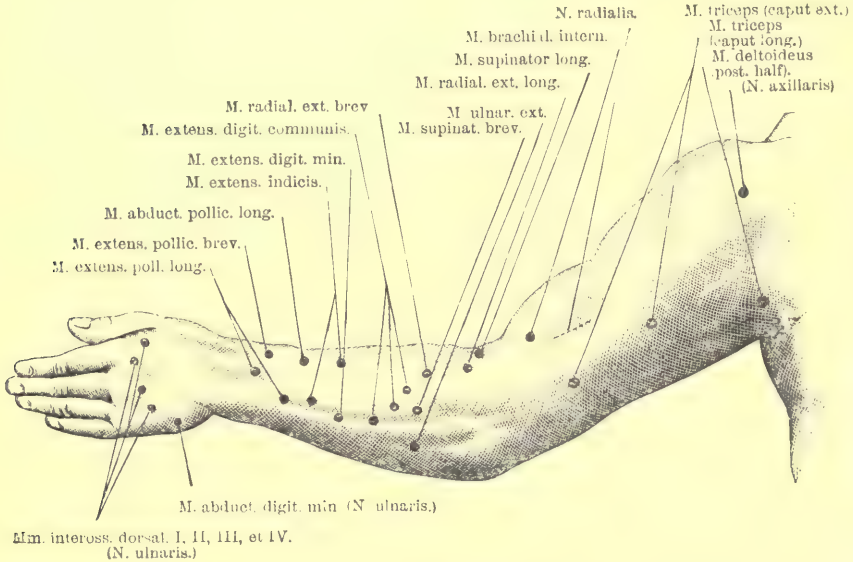


FIG. 151.—MOTOR POINTS OF THE RADIAL NERVE AND THE MUSCLES SUPPLIED BY IT: DORSAL SURFACE.

As regards the qualitative changes greater care is needed. We begin with the cathode placed about the surface of the motor point we are investigating. If we make contact with the negative pole, we have the *kathodal* closing contraction. If we use the anode, it is the *anodal* closing contraction, or A.C.C. Normally K.C.C. is greater than A.C.C., and A.O.C. than K.O.C. In various nerve diseases this is altered, and we have the reverse and other modifications; these we call polar changes.

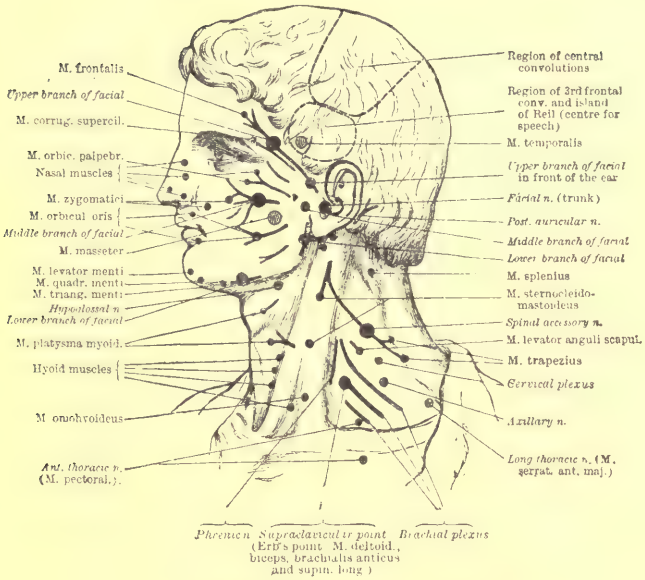


FIG. 152.—MOTOR POINTS OF FACE.

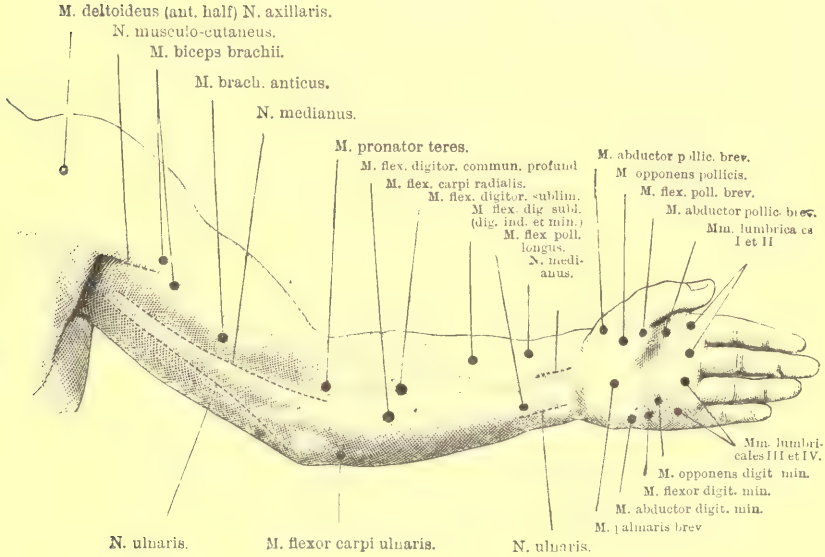


FIG. 153.—MOTOR POINTS OF THE MEDIAN AND ULNAR NERVES, WITH THE MUSCLES SUPPLIED BY THEM.

We have spoken above of testing electrodes with an interrupter on the handle; these are not recommended. The interrupter is liable to lose its insulating properties, so that the patient gets a shock when least expected, as may also the person examining. The best way to break the current is at the battery or switchboard. If a battery

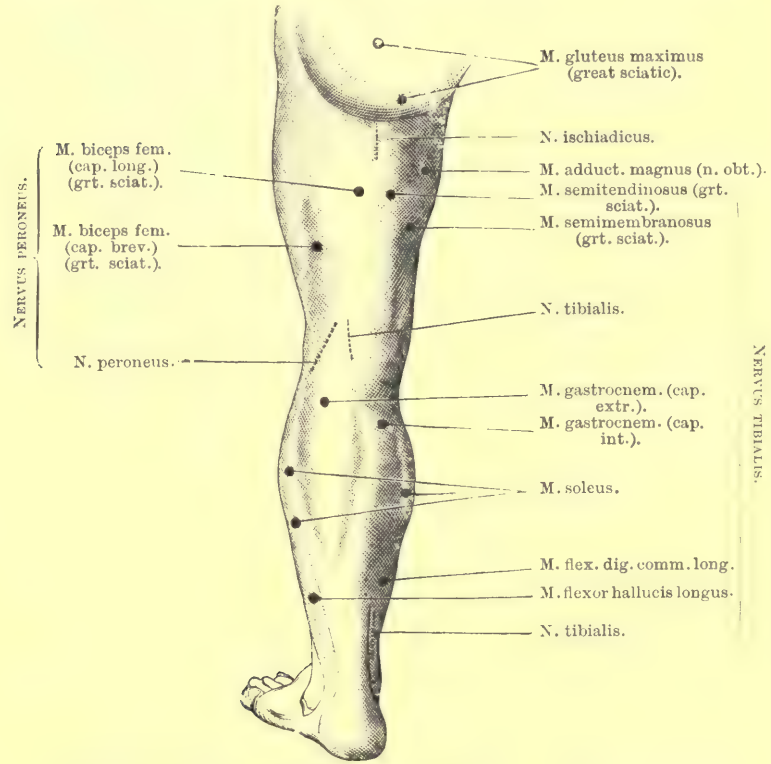


FIG. 154.—MOTOR POINTS OF THE SCIATIC NERVE AND ITS BRANCHES: THE PERONEAL AND TIBIAL NERVES.

be used, the handle of the collector may be moved off and on the dummy knob, which is unattached to a cell, usually the second knob of the collector. If the collector is a single one, then we may use the de Watteville commutator.

Reaction of Degeneration.—This occurs in a nerve when it is severed or is the seat of acute inflammation. When it sets in, the application of a faradic current over the muscle

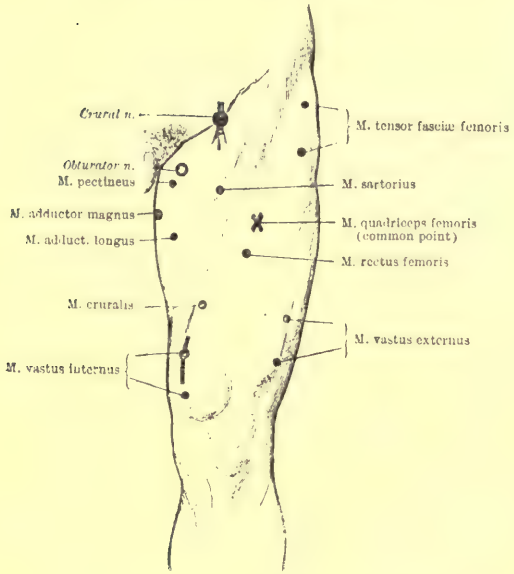


FIG. 155.—MOTOR POINTS OF THIGH.

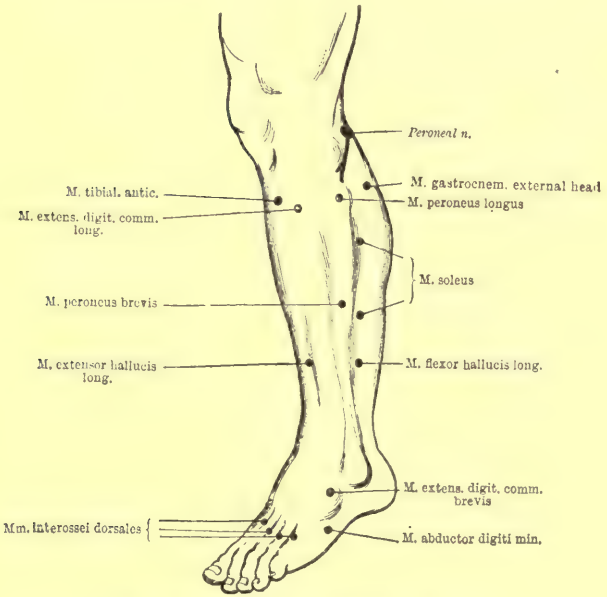


FIG. 156.—MOTOR POINTS OF LEG.

or motor point no longer produces any contraction even with a very strong current. A galvanic current also fails to produce the quick twitch characteristic of normal muscle. A sluggish contraction, slow to develop and slow to relax, is seen, often larger than would be produced in a normal muscle by the same strength of current. The response comes from the altered muscle, and not from the stimulation of the nerve-endings in it; it is known as hyperexcitability to galvanism. This condition is usually established about the third week after the lesion has taken place. After two or three months the response to galvanism also fails, though for a year or more an anodal closing contraction may be obtained by a gradually increasing strength of current.

If the lesion does not involve complete severance of the nerve or ablation of the centre, then, of course, there are all varieties and degrees of the above.

The Use of Galvanism.—As a preliminary, all switches must be examined, the crank collector be at zero, reversing switch at *N*, and the galvanometer shunt adjusted for the strength of current we are likely to use—to register, that is, in units or tens, as the case may be. Cords must be in good order, and metal ends clean and free of verdigris. It is usual to employ a green cord for the negative and a red cord for the positive. Electrodes must be firmly attached, and before starting the operator should test the current on his own hand.

The patient should be seated or lying in a comfortable position, with the parts to be treated well supported and the clothes guarded by towels or waterproof fabric. The electrode should not be applied over any skin abrasion, or, if so, they should be protected by collodion or adhesive plaster. As mentioned above, the pads or leather-covered electrodes are soaked in alkaline hot water, and carefully and firmly applied. The limb or part treated should be as far as possible protected from the cold when treated.

The current is turned on very slowly from peg to peg when a battery is used, or the resistance cut slowly out in a switchboard. The patient has no painful sensation normally, but a slight pricking feeling, to which he soon gets accustomed.

The various ways of application are bipolar and unipolar galvanism.

(1) In bipolar both the positive and negative electrode are placed on the part being treated.

(2) In unipolar only one pole is used in the treatment of the condition, and is known as the active electrode. The other pole is referred to as the indifferent electrode, and merely used to complete the circuit, being applied to some remote part of the body or through a foot bath.

Treatment may be, further, stabile or labile. The former is the most common, perhaps. But with labile we move the electrode up and down, either in the form of a roller or sponge or disc electrode which has been soaped.

General Galvanism is applied all over the body, but is perhaps best applied by means of a galvanic Schnee bath.

Central Galvanism is a valuable form of treatment in neurasthenia and functional troubles. In it a large flat electrode is attached to the negative pole and applied over the hypogastrium just above the navel, while the positive pole is applied by means of a small disc electrode to the forehead and vertex. The current should be a low one of about 3 to 5 milliamperes. After the forehead and vertex have been treated for about five minutes each, the electrode may be then passed up and down the spine for a further ten minutes, the current being allowed to increase up to 10 milliamperes.

Faradism : Method of Application.

Faradism is free of all danger of burning, and the only pain it causes is by overstimulation of a muscle, causing cramp, which, however, is easily allayed and easily avoided with care. It is used for various purposes.

1. For skin stimulation, when a brass-wire brush is applied directly to the skin by the labile method, with a large flat plate as the indifferent electrode.

2. It may be conveniently applied by the Schnee four-cell bath to the whole body, or by means of the masseur's hand in electric massage, which is an exceedingly effective way of stimulating the muscles and system generally. As a

rule this is preferable to the use of an electrode by the labile method, in which the electrode, well lubricated with soap, is moved up and down the body surface.

3. The surging treatment has been of great use in the treatment of soldiers suffering from wounds involving the severance of nerves, which have been sutured, involving the very considerable wasting of muscle. Fairly strong currents are applied over large areas. If the leg is being treated, one electrode is on the thigh and the other the ankle. They are carefully bandaged on. The current is weak at first, gradually increased, and then rhythmically increased and decreased. This surging effect is effected in the very largely used Bristow battery by pushing the iron core in and out, and, if a sledge coil be used, by moving the secondary backwards and forwards.

An apparatus worked by a cam and motor is the most efficient and the sensation most agreeable; no pain is caused the patient by the periodic fluctuation of the current.

Primary and Secondary Currents.—A general rule was laid down by Duchenne that the primary current is best adapted for the stimulation of deep-lying organs such as the stomach, bladder, and rectum, while the secondary currents are best suited for the stimulation of cutaneous nerves and the muscular system. The primary current is, generally speaking, best for the Schnee bath.

The Technique of Faradization.

The faradic current may be applied locally or generally, and by the stabile or labile methods.

The electrodes are similar in character to those used for galvanism, but there are some special types, such as the wire brush electrode. The sponges or leather covering should be moistened with salt and water, or if the sensory nerves are to be treated the skin should be dusted with cimolite or starch powder.

The large indifferent electrode should be placed at some remote part, such as the lumbar muscles, or the patient should hold it in his hand.

General Faradization brings every portion of the body under the influence of the current so far as is possible by outward applications.

The patient should be seated on a stool facing the instrument, and for the first part of the process should be stripped to the waist, and have his shoes and socks removed; his feet should be placed against a copper sheet warmed by means of a hot-water bottle; the surface should be moistened with warm water, and it should be connected with the negative pole of the battery. If the patient is paralyzed, he may lie on a couch with the copper plate beneath his buttocks. The other electrode consists of a brass ball (6 inches diameter) covered with damp wash-leather or felt, or the moistened hand of the operator, connected with the anode.

When the hand is used as the active electrode, the covered brass ball electrode should be held in the other hand, or allowed to rest on a table and be lightly touched at first with the other hand. The strength of the current can then be gauged by the operator's own sensation, and the flexibility of the hand allows of easy adaptation to varying surfaces. A very mild current should be used at first, and gradually increased.

The moistened hand should be first applied to the patient's forearm, and the circuit then completed by placing the other hand on two covered brass electrodes—the positive pole. The hand is then passed over the moistened hair of the patient's head, over his neck, throat, up and down the spine, arms, and hands, then the surface of the abdomen, and finally the legs. Duration of séance, from five to twenty-five minutes; fifteen minutes is a very average time, apportioned in the following manner:

Head	1 minute.
Neck and throat	4 minutes.
Upper and lower extremities ..	4 ,,
Abdomen	3 ,,
Back	3 ,,

The treatment is applied about three times a week, the length of the course entirely depending on the chronicity

and nature of the case dealt with. After the treatment the patient feels considerably invigorated, the sensation of exhilaration continuing for several hours; sometimes drowsiness results. The pulse is steadied, depression relieved,

FIG. 157.—ELECTRIC MASSAGE.

The current is here led from the main—after suitable resistance has been interposed—by a cord (not seen in illustration) to the spongio-piline pad under the operator's left hand. The patient lies on the negative (plate) electrode. It is often preferable for the operator to draw the current from a moist sponge electrode which he holds with varying firmness in one hand, while he uses the other hand as an electrode, and with it massages the patient. In this manner current strengths can be graduated with much precision, and faradism can be rendered extremely agreeable and painless. The flexibility of the hand and its adaptability to any surface of the body renders it a most excellent electrode.

appetite and digestion improved, and muscular energy and body-weight increased. Sometimes there is slight soreness of the muscles.

THERAPEUTIC INDICATIONS.—*General faradization* is useful in the treatment of various functional nerve diseases. such as hysteria, neurasthenia, and nervous dyspepsia, It improves the tissues of the muscles in various paralytic conditions, and takes the place of exercise and massage.

Galvano-Faradization.—The combined use of galvanic and faradic current, as suggested by de Watteville, is effected by uniting the secondary induction coil and galvanic battery in one circuit, by connecting with a wire the negative pole of the one with the positive pole of the other; the electrodes are attached to the two extreme poles, and both currents are sent through the body. The special key of de Watteville is useful in this combination. The effect of this combined current is at once stimulating and soothing.

The Condenser System for Muscle-Testing.

The late Lewis Jones suggested this procedure, which has received considerable attention of late years in war hospitals as a means of stimulating partially paralyzed nerves and muscles. It is an alternative to using interrupted galvanic currents by the Leduc interrupter or faradic currents from an induction coil. The claim for superiority lies in the fact that neither of these can be properly measured, and that therefore no record can be kept, so as to give just the same treatment in any other case.

From no faradic coil, either, can an impulse so short as $\frac{1}{24000}$ of a second be obtained, which can be effected with the condenser system. There is no difficulty either in calculating the time which any condenser discharge lasts; and, further, by arranging a system of known capacities and charging at a known voltage, we have at once a system by means of which muscle-testing can be carried out and the results accurately recorded in terms of the discharge, noting the times necessary to give response in any individual case.

Jones's apparatus has been modified by Dr. Hernaman Johnson, so that the system can be used for faradization without any alteration. The metronome used is motor-driven, and so arranged that its speed can be varied from one impulse every two seconds to about 600 per minute

for treatment purposes. At the latter speed effects are obtained very similar to those given by a faradic coil, but we have the advantage of accurate measurement, the number of impulses being shown by a speed-counter attached to the spindle of the metronome.

The various studs of the regulation switch are engraved with the discharge times which are obtained from Lewis Jones's original paper, and are based on the assumption that the patient's resistance is 1,000 ohms. Three addi-

FIG. 158.—LEWIS JONES CONDENSER TESTING SET.

tional studs are provided, making fifteen in all, and give a capacity of 2 microfarads.

When the apparatus is worked from a 200-volt circuit, the 100 volts necessary for charging under ordinary circumstances are obtained by connecting two similar incandescent lamps in series, and taking the wires from one only to the condenser apparatus.

If there is difficulty in obtaining a response, and it is necessary to charge at double the voltage, as advised by Lewis Jones, the primary connections must be altered so

as to use the full 200 voltage. The patient's circuit must also be adjusted so as to include 5,000 ohms resistance.

These adjustments are rendered unnecessary in the newer type of apparatus, and all the necessary alterations are made automatically when the handle is passed from the twelfth to the thirteenth stud. Nos. 13, 14, and 15 are repetitions of the previous three so far as capacities are concerned, but charged and discharged under new con-

FIG. 159.—HERNAMAN JOHNSON MODIFIED CONDENSER APPARATUS.

ditions. There are therefore a series of fifteen different periods of increasing lengths of discharge duration, all controlled by the movement of one handle, so that the manipulation is fairly simple.*

The metronome is arranged with two beams which makes the apparatus earth-free. It is provided with a voltmeter

* For further details, see *Lancet*, February 19, 1916.

to calibrate the set when first installing, so as to give accurately 100 volts for the first twelve studs and 200 for the final three. It is suited for any direct-current circuit of 200 to 250 volts.

A further modification is the addition of a mercury-jet interrupter arranged to charge and discharge a variable condenser, and the motor which drives the interrupter also operates a liquid rhythmic interrupter, through which the discharge is passed to the patient. The current is very pleasant to take, and perfectly even.

CHAPTER II

THE DYNAMO

When dealing with currents from the main it is highly important to have some conception of the structure and manner of working of the dynamo by means of which the electric current is most commonly generated. Electric current in reality is but the conversion of another form of energy into electrical energy, and the prime motive power may be either water, motor or turbine steam engine, steam turbine, gas or oil engine, etc., entirely depending on circumstances. Water-power is greatly favoured where the natural lie of the land is such as to provide abundant river falls, etc., such, for instance, as in Canada, United States, and other parts of the Continent. One of the best instances of harnessing such natural powers is to be found in the Niagara Falls of North America, where there is an installation with a distributing voltage in the neighbourhood of 60,000 volts, which is spread over large areas by a network of wires supplying lighting and power for commercial purposes at suitable voltages. In Great Britain, owing to the paucity of large river falls, steam power, either in the form of steam engine or turbine, is the most favoured, coal being, generally speaking, comparatively abundant in many districts. Gas and oil, however, are coming into use, and find favour for special installations where the electric power is required for manufacturing and other purposes. The dynamo consists of two main parts, no matter whether intended to give alternating or direct current—viz., the stator and the rotar. The former, in the case of the ordinary direct-current machines, is called the field magnet, the latter the armature. The armature is composed of sheets of laminated iron around which is wound coils of insulated copper wires, generally in specially prepared slots to receive

same. The ends of this wire are connected with two copper rings fixed to and insulated from the axis or the shaft of the armature, or to what is called a commutator, which is composed of a cylinder divided up into a number of sections, depending on the arrangement of the windings on the armature. Collecting brushes rub against the rings or commutator, and connect the machine with the external circuit wherein the power is to be absorbed.

In most modern direct-current dynamos there are four, six, eight, or more pairs of poles, depending on the speed the dynamo armature rotates at when giving its maximum voltage, this being limited to the design of the steam or other engine which will have to drive the same. In the case of large outputs multipolar machines have many advantages. When, however, we are dealing with alternating currents, the number of poles is a factor upon which the periodicity depends, especially where high values and limited engine speeds are concerned. The field magnetism may be maintained in a variety of ways: (1) By permanent magnets, which, however, now have very limited application, and are chiefly to be found in telephone circuits and in the magnetos of motor-cars for ignition purposes. (2) The magneto may be of soft iron, and independently excited by batteries, but the most common way is self-excitation—that is, the armature is connected either in series or shunt with the armature. This presumes, however, that there is a certain amount of residual magnetism remaining in the iron of the field magnet; if not, a momentary current must be passed through the same, and in both cases the action is as follows: The armature as it rotates in even a weak field moves current which passes round, the exciting of the field coils tending to strengthen same, the effect of which is to increase the induced E.M.F. of the armature until its full pressure is obtained, which will result in a maximum of excitation. Great care must be taken to see that the current flowing from the armature passes in the correct direction around the field—that is to say, in such direction as to strengthen same and not to neutralize it. There are two usual ways of connecting the armature to the fields for excitation purposes—shunt and series winding. In the

shunt the full output of the armature is applied to the field, and only a small fraction of current generated; it passes around the field many times, rendering it very powerful; or, in other words, a fixed number of ampere turns. It might be here stated that the strength or number of lines of force of a magneto depends on the product of the current and the number of turns of wire.

The other method is known as the series excitation—that is, the field varies with the value of the armature current, which the speed, being constant, varies as the external resistance of the load.

When dealing with motors, the matter of series or shunt wound construction is a very important one. The shunt connection gives a practically uniform speed irrespective of the load, so long as the latter is within the limits of the machine specified; on the other hand, with the series arrangement the speed varies with the load, being slow with a heavy load and fast with a light one.

Current from the Main.

Once X rays came into general use, electrical methods changed entirely, and means had to be found for harnessing high voltage currents from the main for electro-therapeutic purposes. The electric current is not generally available in both small and large towns; in the latter the voltage is generally 200 to 250, either direct or alternating in character —in the latter case the periodicity varying from 40 to 100 periods per second. In many towns both types of supply are to be found. From a medical or electro-therapeutic point of view the continuous current has advantages, but where X-ray work is concerned and powerful apparatus is required has now become more popular, as it reduces the primary cost. The alternating current is in large towns distributed at a very high voltage, of 2,000 to 10,000 in many cases, and as the cable enters each house it passes through a step-down transformer in which it is converted down to 100 or 200 volts. Sometimes the reduction is effected in substations.

The advantage of this system to the electric lighting

companies lies in the fact that the copper cables employed for the mains need be only $\frac{1}{10}$ to $\frac{1}{100}$ of the thickness required for the distribution of the same quantity at low voltage.

The number of amperes which a cable can carry without becoming hot is limited, and ought not to exceed 1,000 amperes per square inch (cross-section) of copper. The number of volts, however, can be raised as far as the safety of the insulation permit; as many as 30,000 volts have been used in wires suspended on porcelain insulators on telegraph-poles and sent over a distance of more than 100 miles. A copper cable with a cross-section of 1 square inch can carry 100,000 watts only with 100 volts, but 5,000,000 watts with 5,000 volts. The net gain to the electric company from the commercial point of view is not nearly so great as the figures imply, because the cables for 5,000 volts require a much better insulation than those for 200 only. Further, accumulators cannot be used with the alternating current, and the engines therefore have to be kept running all day, and there is ultimately some loss in the transformers fixed in the consumers' houses whenever the current is not being used. Notwithstanding all this, the alternating current requires to be employed whenever it is to be sent over long distances.

The constant current or direct current is necessary for ordinary electro-therapy, ionization, electrolysis, etc.

It is obvious that the nature of the supply in any town will depend on factors such as water-power, coal-supply, etc.

Transformers.—These are of two kinds—static and motor.

The *Static* or stationary transformer is, strictly speaking, an alternating-current machine, and is usually placed in the cellar of a house drawing its supply from a high-voltage main in the district; the apparatus is covered by wire protector of some sort to secure that people who are ignorant of its nature do not cause themselves severe shocks or other injury, as the current running through the supply wires may exceed 1,000 volts. This is what is called a step-down transformer.

A small stationary transformer may be used also for attachment to a wall entirely to isolate the current and adjust the voltage for special purposes.

Motor Transformers are of two kinds. The rotatory

converter is the most handy and compact form of machine for obtaining an alternating current from a direct-current supply, and is used in the production of sinusoidal or polyphase currents (see section dealing with these).

Motor Transformers.—These are of two types, the first is known as a rotary converter, and is generally used for converting direct current into alternating, but may be used *vice versa*, provided same is suitably constructed. In design it is really a motor the armature of which has a pair of rings insulated from each other mounted on the end of the shaft, and for convenience at the commutator side, and connected to two points of the armature winding—for example, in the case of a two-pole machine to the two opposite bars of the commutator; upon these rings slide two bushes, to which the external circuit is connected. These machines are excellently adapted for cautery and light work, and for giving sinusoidal current when the supply main is direct current. It is, of course, necessary to introduce a small static transformer with suitable ratio of winding between primary and secondary, so as to obtain the correct voltage and current for each particular purpose. This transformer has the further property of rendering the machine earth-free when the direct-current main is a three-wire system with middle wire earthed.

The second type is called a motor generator, and in general practice is used for transforming direct current at one voltage into either a lower or higher voltage. It may consist, first, of one machine, as described under rotary converters, provided with an entirely separate winding wound in the same armature slots and attached to a separate commutator, which may also have rings for taking off alternating current. In the case of the rotary converter on direct current there is a definite ratio between the input voltage and the output voltage, whereas in the case of the motor generator the voltage may be anything within limits, just depending on the special winding. This type of machine has come to be used largely in medical work under the name of universal apparatus, which is usually arranged to give suitable currents for cautery and light purposes, direct current for galvanism, and sinusoidal alternating current,

all of which are entirely earth-free, even although the motor acts on an earthed system. In the second type of machine, when transforming from direct current of one voltage to another, we have a separate motor running on the main supply, and mechanically coupled to same is a separate generator the windings of which are arranged for the particular voltage required; if alternating current is required, the generator is further supplied with rings. This machine also lends itself for the purpose of converting alternating current into direct current at the required voltage. In this case the motor may be a three-phase one or a single-phase repulsion motor depending on the supply system, which is, as before, mechanically converted to a direct-current generator.

The Safety of using Currents from the Main.—If a shunt rheostat and lamp, as described below, be used, it is scarcely possible for the patient to receive too powerful a current—that is, a *dangerous* shock. Of course, the current may be turned on by mistake while the spring of the rheostat is "strong" instead of "weak," just as this can happen while the current collector of the battery is still full on. In both instances a very unpleasant but not dangerous shock will be given. With the usual system of underground cables, the E.M.F. of a continuous current never rises suddenly to dangerous proportions.

In most installations, however, owing to defective insulation, there is a certain amount of leakage or escape of electricity to earth (Fig. 160). If the three-wire system be used, and the positive pole of the dynamo is connected with earth, a patient, also in good earth contact, may receive a shock when the electrode is applied, even if there is ample resistance, or if this electrode happens to be connected with the negative pole of the dynamo. Such shocks practically never occur, owing to patients being usually well insulated from the earth by a carpet or dry wooden floor. Operators have received unpleasant shocks from holding an electrode in one hand, while they attempted with the other to open a water tap to moisten the electrodes. It must be made a rule not on any account to touch gas or water pipes so long as one hand is in contact with the

switchboard or an electrode. There is really no danger in local applications of the current if this rule is adhered to.

The case is, however, different if the current is to be applied in a bath. A patient might receive even a fatal shock if the necessary precautions are neglected. The

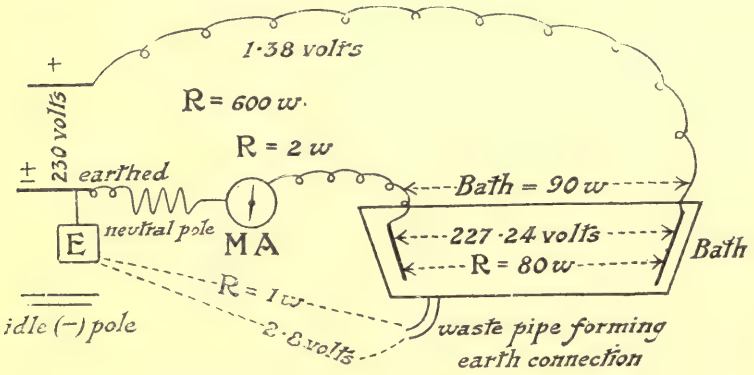


Fig. 160.—Scheme of Electric Bath Circuit to show how Short-Circuiting may take place by Means of the Earth Contact with Waste Pipe.

water in a bath tub, even if the latter is made of porcelain, is usually in excellent contact with the earth through the waste pipes, etc., which are of metal. If the current is intended to be applied in a bath, it is necessary to insulate the water by replacing the metallic waste pipes by others

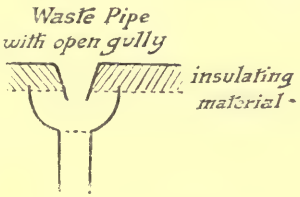


Fig. 161.

made of earthenware for a considerable distance, or, better, to let the bath discharge pipe run into an open gully connected with a main waste pipe (Fig. 161); by enclosing the inlet pipes and taps in wooden cases so that the patient cannot possibly touch them; and by use of a bath tub made of porcelain or wood. If this cannot be done, the metal

bath must be at least placed on tiles of porcelain. If the leakage is bad, or if one pole of the mains is earthed, there should be no current reverser on the switchboard. If the current is used for an electric bath in a hospital or hydropathic, it is advisable to transform it by means of a small motor transformer. This applies to a full hydro-electric bath. But even with a Schnee four-cell it is necessary to secure absolute safety for the patient.

The Switchboard.

Given a supply of electrical current in the house or establishment, we have to proceed to its utilization for

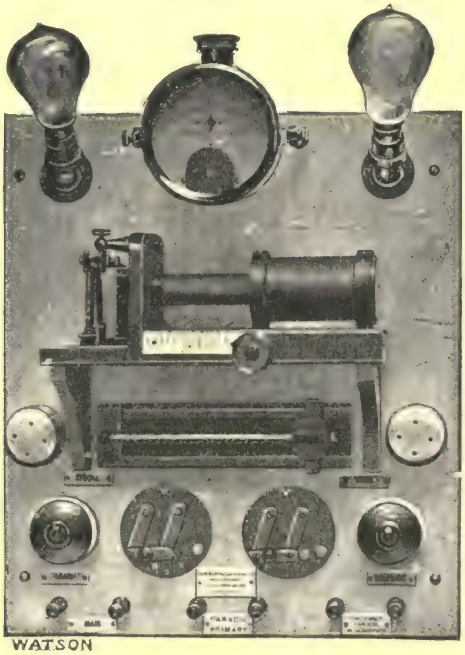


FIG. 162.—THE SWITCHBOARD.

medical purposes. We have the choice of using a switchboard for direct current, or, alternatively, we may employ one of the universal apparatus, such as the multostat, which are earth-free. This is, of course, a very great advantage, and these apparatus are dealt with in detail on p. 335 *et seq.*

Prior to the introduction of these machines, the medical switchboard for galvanism and faradism was in very general use, and is still frequently employed. It enables the physician to treat the patient by means of regulated amounts of the direct current through a shunt circuit. The direct current is led into the board by means of two terminals, which, of course, are positive and negative respectively.

The board itself is now usually made of polished marble or slate. Oak, used a great deal formerly, does not now conform to the Board of Trade regulations. The following essential parts are to be found on a switchboard: (1) Resistance lamps, or the equivalent; (2) safety fuses; (3) a shunt rheostat; (4) the galvanometer; (5) induction coil; (6) de Watteville commutator; (7) reversing switch; (8) terminals for patient and supply.

1. **The Lamps.**—These serve a dual purpose, as for one thing they show the operator at a glance if the current is passing or not, but the main function is to act as a means for absorbing the greater part of the main voltage, leaving only 60 to 90 volts, which can be regulated from zero to this as a maximum by small fractions of a volt at a time.

2. The **Fuse** is merely a safety valve consisting of a gap in the circuit bridged by a piece of tin wire of such size as to safely carry the requisite current, and which will fuse when anything occurs to unexpectedly lower the fixed resistance, and thus cause damage to instruments, etc., by excess of current.

3. **The Shunt Rheostat.**—This is practically the current "tap"; we open or shut it or adjust it at will, and so regulate the amount of current passing to the patient who is being treated and connected directly with it. It consists of a core of slate, around which some 500 or more turns of resistance wire are wound, of such a size as will allow of the maximum amount of current desired. The voltage is adjusted by means of a metal sliding adjustment, which rises on a metal rod running parallel with the slate core and making contact with the surface of the winding at any point. In the above diagram, when the sliding spring is on the right hand near *B*, the E.M.F. between the terminals leading to the patient is only a fraction of a volt. Put in

another way, the resistance through the rest of the rheostat and back to the mains is small compared with that in the shunt circuit containing the patient. The greater portion of the current, therefore, takes the path of low resistance, only a small portion reaching the patient.

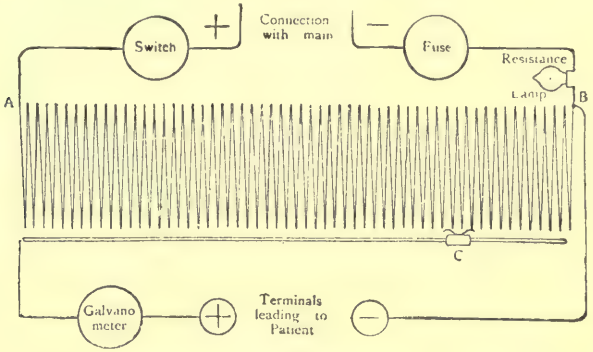


FIG. 163.—DIAGRAM OF SWITCHBOARD WITH LAMP AND WIRE RESISTANCE.

If the spring, however, be moved slowly to the left, the resistance of the circuit through the rest of the rheostat is gradually increased, and a less amount of current passes along it. The current through the shunt circuit to the patient, on the other hand, is proportionately increased.

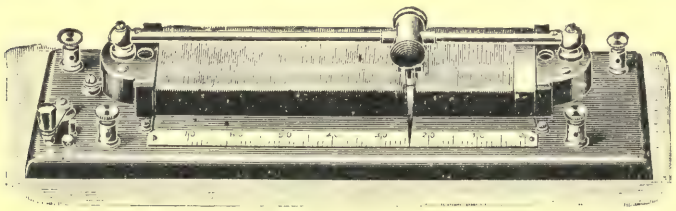


FIG. 164.—THE RHEOSTAT (FINE WIRE).

The change is very gradual, and increase and decrease is made much smoother if the sliding spring work on a rack and pinion.

An elementary principle in beginning is that we start with all the 500 ohms of resistance between the main and the patient, and then slowly cut out according to requirements. The rheostat is marked weak on the left side and strong on

the right, so mistakes need not be made. If the precaution is not taken to see the spring is at the right before beginning, the patient may sustain a dangerous shock.

There are, of course, various types of rheostats. That figured above is most commonly used, but in all the principle is the same. Gaiffe usually fits one with wire windings standing out vertically from the surface of the board, and the cutting out is arranged by means of a movable arm.

4. **The Galvanometer.**—The galvanometer is an instrument in the strict sense for indicating the presence of an electric current, and, as in ionic work and many other forms of medical treatment with electricity, the rate at which any chemical change is brought about by means of the electric current is dependent upon the quantity of current passing in unit time. In this respect the ordinary galvanometer, even the most delicate in construction, is not much good for our purpose, as in medical work we require an instrument which will read directly the current in standard units, and to obtain this it is necessary to use particular types of instruments, and those most adapted for this purpose are the instruments wherein the zero point is unaffected by position of the instrument—that is, it ought to be able to work in a horizontal position or in a vertical one. This leaves us for the purpose of ionic work, utilizing continuous current, with some form of moving coil instrument, the most of which are based upon the d'Arsonval principle, wherein a powerful uniform magnetic field is secured by means of a horse-shoe magnet and specially shaped pole pieces. Moving within these pole pieces is a coil of wire, generally of rectangular shape and mounted upon pivots with spiral springs to maintain the coil in a certain position. When a current is passed through this coil it tends to set itself with its plane so as to include the greatest number of lines of magnetic force. As this work is not intended for dealing with the construction of instruments, we will proceed by stating that a milliamperemeter as above can be made to read currents as small as one-thousandth part of an ampere, and the full scale in most cases is obtained with a matter of 3 to 5 milliamperes. Here, again, this limit of current is only suitable for certain testing purposes and when very

high degree of accuracy is required. For general treatment, however, utilizing ionic work with either large pad electrodes or by means of leg and arm baths, this instrument would be too sensitive. The instrument is, however, so arranged with what is termed a shunt, which is a metallic circuit capable of being connected across the moving coil of the instrument at will, so that only a fraction of the actual current passing is measured on the instrument, the remaining part going through the shunt. If, however, we so arranged the shunt as to have a definite value in resistance to that of the moving coil itself, such as, say, one-ninth, one ninety-ninth part, or one nine hundred and ninety-ninth part of the moving coil, we can then say that the reading on the instrument—if, for instance, we close the shunt representing one-ninth of the resistance of the moving coil—has the multiplying power of 10; that is to say, if the current passing through the instrument before the shunt was attached was 10 milliamperes, then on closing the shunt representing one-ninth of the resistance it would be found that the instrument needle would swing back and read only 1 milliampere. As, however, the current flowing through the moving coil operating the needle represents one-tenth of the current, the remaining nine-tenths passing through the shunt, then it will be seen that the instrument reading requires only to be multiplied by 10 to give the correct reading. This becomes very simple so long as we stick to the above proportional resistance between shunt and moving coil; that is to say, using one-ninth, one ninety-ninth, and so on, the multiplying power is respectively 10, 100, and so on. The older forms of instruments were in most cases subject to terrestrial magnetism; that is, they had to be laid so that the magnetic needle which was then used was lying in the magnetic meridian, which was in reality the controlling force of the instrument. If the instrument, however, was not properly placed at starting, the reading on same would be quite incorrect.

5. **Induction Coil** (see p. 288 *et seq.*, under "Faradism").

6. **The de Watteville Commutator.**—This little piece of apparatus (Fig. 165) enables us to change quickly from galvanic to faradic current without having to alter the

connection of the electrodes or terminals, and to combine the galvanic with the faradic current, which is often of considerable value.

If the cranks point to *G*, the current is galvanic; if to *F*, it is faradic; while if it lies midway between we are using

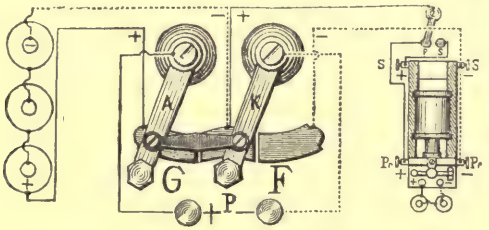


Fig. 165.—De Watteville Commutator

the combined or de Watteville current, so named after the deviser of the commutator.

7. **Current Reversers and Combiners.**—It is important for most physicians to possess an arrangement which makes it possible suddenly to close or interrupt the current, or else suddenly to connect with the negative pole the electrode hitherto connected with the positive pole, and *vice versa*. These sudden changes produce contractions of the muscles,

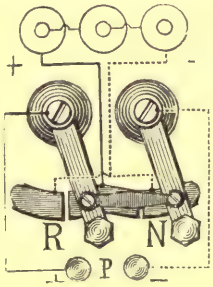


Fig. 166. Current Reverser.

the intensity of which depends on the strength of the current and the sensitiveness and healthiness of the muscle. They are therefore very important for diagnosis. To interrupt and to reverse the current can be managed with a single instrument, of which we give a diagram (Fig. 166). The negative pole of the battery is connected with *R* and *N*

the positive pole with the metal piece between these two. While the cranks point towards *N* (normal), as in the illustration, the right-hand crank is connected with the negative pole, and the left-hand crank with the positive. By moving the cranks slightly to the left, so that they rest on *R* and *N*, both cranks are in contact with the negative pole: consequently there is no current at all; but if we move the cranks farther, so that they point towards *R*, the left-hand crank is connected with the negative and the right-hand crank with the positive pole. From each crank a wire leads to a terminal screw.

Current reversers are manufactured in many shapes, but in principle their construction is always the same.

8. Two terminals, usually at the side.
9. If we require faradism, a sledge coil must be added.

The Galvanoset.

This is a patented device for using currents from the main for medical purposes by an exceedingly simple process. The apparatus is a potential divider, tap water replacing the usual metallic resistance wire. The water is contained in a heavy glass vessel about 9 inches in diameter and 4 inches deep. Two carbons similar to those used with the arc lamp dip into the water vertically, and are placed as far apart as possible. They are fixed to the ebonite cover of the vessel, and to them are attached the patient's terminal with milliamperemeter included in the circuit. A horizontally rotating arm moves around a central vertical axis just below the cover, and carries on its two ends vertical carbon electrodes, between which the main current flows through the water.

When the plane of the two movable electrodes is at right angles to the plane of the fixed electrodes the potential at the patient's terminal is zero, whilst when turned through 90 degrees—*i.e.*, when the plane of the fixed electrodes coincides with the movable electrodes—the potential is maximum. Further, when the planes are at right angles to each other and the movable electrodes at the front or at the end of the bar carrying the electrodes, and under the

sign plus is made the positive pole, then the fixed or patient's terminal towards which this is made to move becomes the positive pole of the patient.

It is found that when a pressure of 100 volts is applied between the fixed electrodes, a maximum current of about 200 milliamperes flows in the derived circuit. It compares very favourably with an ordinary galvanic battery, both

Fig. 167.—Galvanoset, with Faradic Coil attached.

as regards expense, wear and tear, and readiness for use; also as regards its range of adjustment and ease of keeping in order. The weight is only 7 pounds, and the whole apparatus goes into a light portable case.

The diagram above shows very clearly the electrical connections. It will be seen that the current from the main passes through a switch, and then to a lamp on to one of the movable electrodes, thence by the liquid to the

other lamp, and so to the other pole of the main. The supply terminals are mounted on an insulated bar of vulcanite, arranged so that it is free to rotate over a graduated celluloid

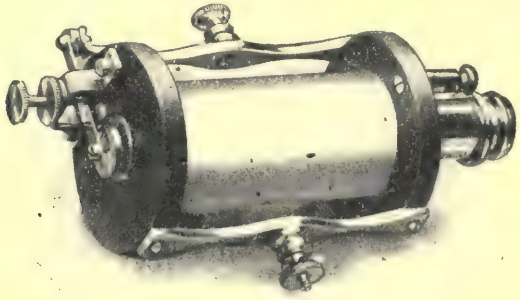


Fig. 168. The Faradiset.

scale. If this disc is now rotated from its right angle or zero position, any desired current can be obtained from a minimum to a maximum by the most gradual increase.

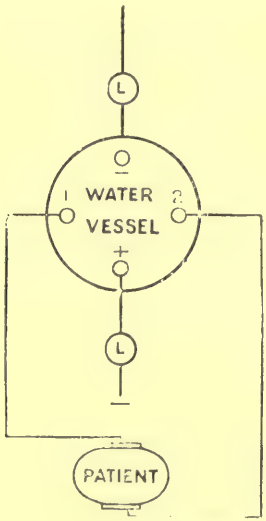


Fig. 169.—Scheme of Circuit in Galvanoset.

If it is desired to reverse the polarity of the current leading to the patient, it is only necessary to bring the bar to the zero position again, and to continue to rotate it in the

opposite direction. By moving the lever backwards and forwards over the scale, an undulating reversing current is obtained. The frequency of these undulations can be increased or decreased by varying the speed at which the lever is moved—a thing which is impossible with an ordinary galvanic battery. By it one can give a galvanic current

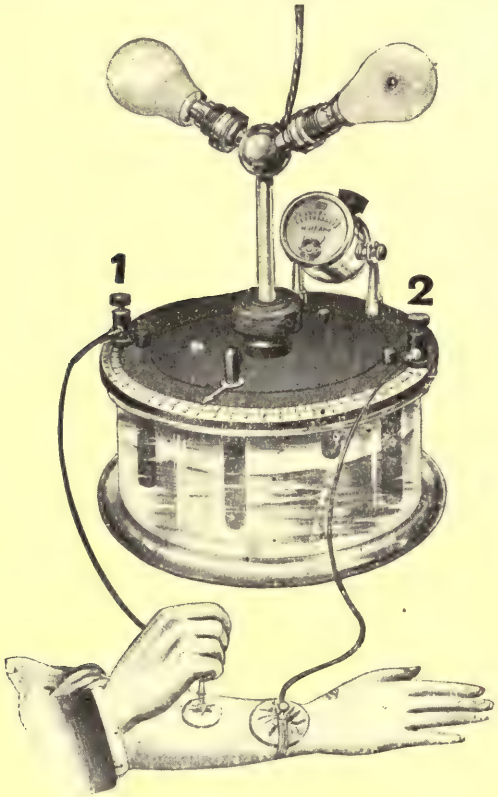


FIG. 170.—GALVANOSET IN ACTION

with every variation from 0 to 500 milliamperes at any voltage from zero to the maximum required, and with absolute safety under ordinary circumstances. There is a great advantage in this apparatus over a switchboard utilizing rheostats of nickel wire, as the wire at times breaks and causes the patient a shock. Moreover, the surface may

oxidize and cause irregular contact, which in the case of the galvanoset cannot happen. With a wire rheostat, moreover, the patient is always connected with one pole of supply, and if he gets into contact with the opposite pole he is in the main circuit. A recent improvement in the galvanoset is making the positive "carbon" of platinum, which prevents the disintegration which sometimes takes place in water, producing sediment of carbon dust.

Instructions for Using.—The vulcanite top should be removed after loosening the vulcanite fixing buttons, and ordinary tap water is introduced into the glass vessel to the depth of 3 inches. The vulcanite top is then fixed on again, and resistance lamps introduced to their sockets. The scale-pointer must be set to zero, the milliamperemeter properly swung, and the whole apparatus connected with a lamp-holder. When the current is switched on, the polarity must be first ascertained

The lamps will glow faintly after a few minutes, but not at first. To determine the polarity the apparatus connected to the lamp-holder is put in the circuit. After a few seconds one of the carbon electrodes will be observed giving off small bubbles of gas in the form of a local cloud—this is the negative pole. A smaller quantity of larger bubbles are seen on the positive pole. Alternatively, pole-finding paper may be used. If the carbon at the back of the vessel beneath the milliamperemeter is the negative when the pointer is at zero, then the connection is correct. If otherwise, the plug must be removed, given a half-turn, and then again put into the lamp-holder. Both polarity and intensity of the current are controlled by an adjusting lever. If the lever is moved over the left-hand half of the scale, the left-hand patient terminal becomes *plus ;* while if the lever is moved over the right-hand side of the scale, the right-hand patient terminal becomes *plus*, and *vice versa*. A peculiarity of this machine is that the reversal of the polarity causes no shock. Voltage and milliamperage are controlled by the scale-pointer, and any voltage up to 80 can be obtained.

The apparatus is specially well adapted for use with a Schnee four-cell bath (see Fig. 170), a special four-way

connection being used. Currents may be used in all directions and for any set of cells by merely adjusting this special switch.

The galvanoset is also supplied with a faradic coil, and in order to utilize this the milliamperemeter is removed from its stand and the faradic coil hung in the supporting pillars in place of it. The insulated bar provided is connected with the patient's terminals. The contact-breaker should be inwards, nearest the centre of the apparatus. These are always adjusted before being sent out, but the ideal adjustment is to have the hammer about $\frac{1}{16}$ inch away from the iron core which attracts it. When the hammer is depressed, the platinum contact on the spring should leave the platinum point attached to the platinum screw in order to break the current. It is well not to interfere with the adjustment of the contact-breaker once it is put in order. The patient is

Fig. 171.—Four-Way Connectors.

now connected to the terminals at the end of the coil by withdrawing the little metal sleeve, situated at the opposite end of the coil, on which the contact-breaker is placed. The intensity of the current entering the coil will be governed by the position of the galvanoset lever. Usually this has to be placed at about No. 90 on the scale.

Multiple Treatment.—In hospitals several patients may be treated at once by means of the four-way adapter (Fig. 171). The peg projection is clamped into the patient's terminals at either side of the galvanoset. Any number of patients up to four can then be treated by connecting them to the four sockets on either side of the instrument that will be provided by this means. The four-way connectors are, of course, used for the four-cell bath also.

The Multostat.

This is one of the several types of universal apparatus. In a very small space this machine contains all the necessary controlling and regulating fittings for galvanism, sinusoidal

current, faradism, and the combined current, as well as cautery, light, and motor transformer. The whole of the apparatus is in a dust proof iron case, 18 inches by 18 inches, on the top of which the motor transformer is fixed. The case is heavy, weighing in all about 75 pounds, but a smoothly running table on castors is provided for its easy transit.

These machines can be made to suit either continuous or alternating mains. The current consumed is so small that it can be supplied from any lamp-holder. Perhaps the

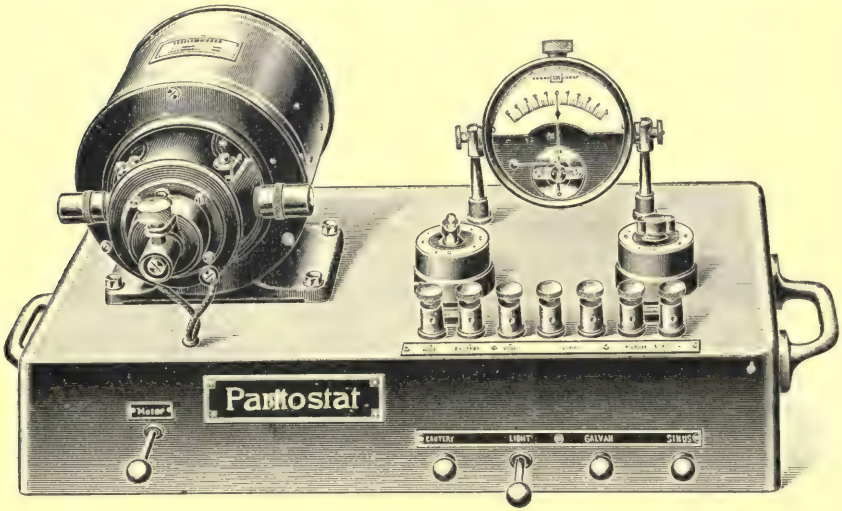


FIG. 172.—THE MULTOSTAT (PANTOSTAT FORM).

most striking proof of the adaptability of the mechanism is the ease with which it can be used for the cautery or light. In the case of a direct current we use a motor transformer to convert the direct current into an alternating one, which is passed through the primary of a small static transformer, the secondary of which is so arranged to lower the voltage to the required level, while the winding is of such diameter as to admit of the use of the heavy currents required for light or cautery.

The current consumption is very low, as the apparatus can be run for about twopence an hour. The apparatus is also

entirely earth-free owing to the use of the motor transformer.

A milliamperemeter is provided registering up to 500 milliamperes, which permits of very fine work being done. The speed of the motor can be nicely adjusted, as is necessary in vibratory treatment and the working of the sinusoidal. Apart from medical uses, of course, the axle of the motor can be put to various very handy mechanical purposes. If the supply be alternating, special adjustments are made with a repulsion motor coupled to a direct-current generator with commutator and brushes, the latter being connected to a shunt rheostat, by means of which the potential is varied from zero to 90 volts or thereby on the patient's terminal. The current for the primary of the cautery and light transformer in the case is taken direct from the alternating supply.

If there be no direct supply from the main to the house, the multostat can be run from a battery of six accumulators with a capacity of 60 ampere-hours. The advantages of such a *multum in parvo* to a medical man are obvious; there are no cells to get out of order if the main current is available, neither is there anything to repair. The apparatus is about as "fool-proof" as can well be imagined. The writer has had one in use almost daily for ten years, and there has not been the slightest breakdown or mishap, and it works just as when first obtained. Should occasion arise at any time to inspect the inner working of the machine, the bottom plate is taken off by the removal of a few screws.

There are several types of these machines, all alike in principle. The Polytherap, an American, differs in that X rays can be generated from it as well. We may briefly enumerate the advantages as follows:

1. Absolutely true galvanization is obtained.
2. No chance of earth leakage.
3. Inner workings closed and dust-free.
4. Freedom from breakdowns and absolute reliability in working.
5. Smoothness in regulating current of any type, owing to the use of a precision type of turning rheostat.
6. Specially enclosed motor of absolute reliability.

7. Can be built for direct or alternating current.

8. A very clear arrangement of switches, rheostats, and meters.

9. Great ease in graduating currents by rheostats and regulating motor speed.

10. Compact construction and ease with which the machine can be taken from one room to another in an institution.

11. No necessity for fixing to a wall, as with a switch-board.

Sinusoidal Currents.

The word "sinusoidal" has been used to describe a wave-like alternating current, such as is produced by an alternating-current dynamo, and to distinguish it from the irregular, jerky alternating current produced by a faradic

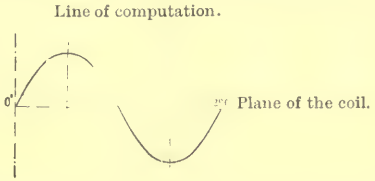


FIG. 173.—CURVE OF A SINUSOIDAL CURRENT.

coil. When a copper coil rotates with uniform velocity between the poles of an electro-magnet, the current collected is sinusoidal—*i.e.*, its intensity is proportional to the sine of the angle between the plane of the coil and the line of commutation.

FIG. 174.—CURVE OF THE SECONDARY CURRENT OF A FARADIC COIL.

Figs. 173 and 174 respectively show the curves of a sinusoidal current and the more jerky movement of the secondary current of a faradic coil. The latter type produces somewhat painful contractions of the muscles, whereas the

smooth sinusoidal currents may cause equally powerful contractions, but they are not so much felt by the patient. They are also free from the electrolytic effects produced by a continuous current.

We distinguish between single-phase and polyphase sinusoidal currents. For medical purposes three-phase

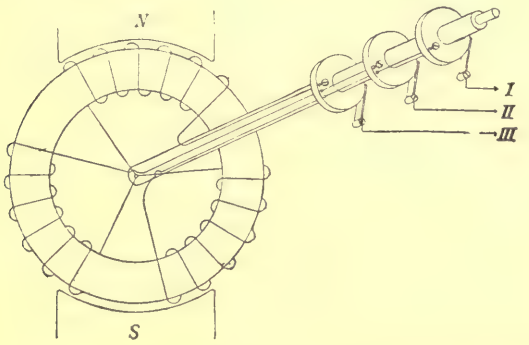


Fig. 175.—Diagram showing Arrangement for producing Three-Phase Currents.

currents are frequently employed, and to obtain them a peculiar connection of the winding of the armature is necessary. It is arranged in three groups, each of which occupies one-third of the circumference of the armature. One end of each group is connected with one of the three collecting rings shown in the illustration (Fig. 175), and the

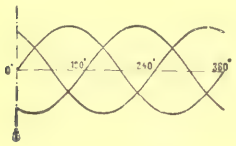


Fig. 176.

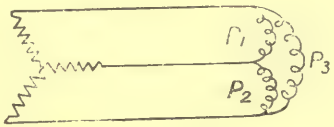


Fig. 177.

other ends are connected together. While the first group is near the north pole of the dynamo, the second is 120 degrees farther ahead (Fig. 176), past the neutral point, and on the way to the south pole; the third group is 240 degrees ahead, past the south pole already, and approaching the second neutral point. Three separate waves

are thus generated, and are interwoven as shown in Fig. 177, in which the three zigzag lines on the left represent the three groups of wire on the armature, and the dotted curves on the right the three waves of current in the external circuit passing through the primaries of the three sledge transformers.

The most convenient way to produce sinusoidal currents is to have a continuous-current motor provided with extra collector rings, from which the sinusoidal current can be taken off. If it has two rings, single-phase currents only can be obtained; if it has three, we may use single or three-phase currents. In the first instance two, and in the second three, electrodes will be required for the patient. The three-phase current is the most pleasant sensation, and a fairly powerful current can be employed without pain or discomfort to the patient.

The Herschell-Dean Triphase Generator.

This apparatus, which we have used for a number of years with satisfactory results, consists of a field armature with a commutator having equidistant tappings connected to slip rings, on which brushes are held in contact by small springs. The triphase currents are carried by flexible connecting cords to the primaries of three induction coils arranged as in Fig. 178. Instead of the secondaries moving, as is more usual, the primaries are moved by means of a rack and pinion adjustment, preventing jars and unevenness. The secondaries of the coils are also connected up in a similar manner to the primaries. The current is led from the coils to the electrodes by ordinary flexible cords which are attached to a trident plug, which simplifies the manipulation of the cords. The electrodes being in intimate contact with the skin, the circuit is formed within the organism. The E.M.F. in the primary is controlled by a rheostat, and the periodicity by a break, which acts by virtue of the load borne by the generator, and reduces the number of revolutions. If the break be gradually applied with the machine running at full speed, a progressive reduction in revolutions and alternations is caused without

change in E.M.F. of the currents. The machine should never be suddenly stopped with the electrodes in contact with the patient, or he will receive a shock. To stop the administration, the primaries must be moved back to starting-point, the rheostat be put at "weak," and the current switched off. The electrodes may then be safely removed.

Two distinct types of current are obtainable: (1) A rapidly alternating current, with powerful action on

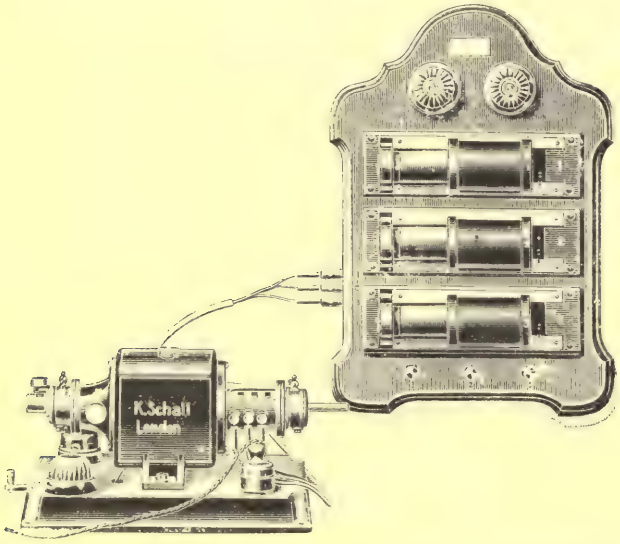


Fig. 178.—Triphase Apparatus for Direct Current Main.

metabolism and markedly tonic effect; and (2) a slowly alternating current, capable of especially influencing non-striped muscle tissue and causing painless contractions.

The triphase current may be applied—(1) By electrodes, large flat felt or sponge electrodes being best suited for skin surfaces. Gastric and rectal electrodes are also employed. (2) By means of local baths, single or multiple (as in the Schnee bath). (3) By a general full bath. (4) External electrodes may be combined with baths.

Herschell found an application of the triphase currents

(1) increases the tension and amplitude of the pulse; (2) increases excretion of urea; (3) increases the peristalsis

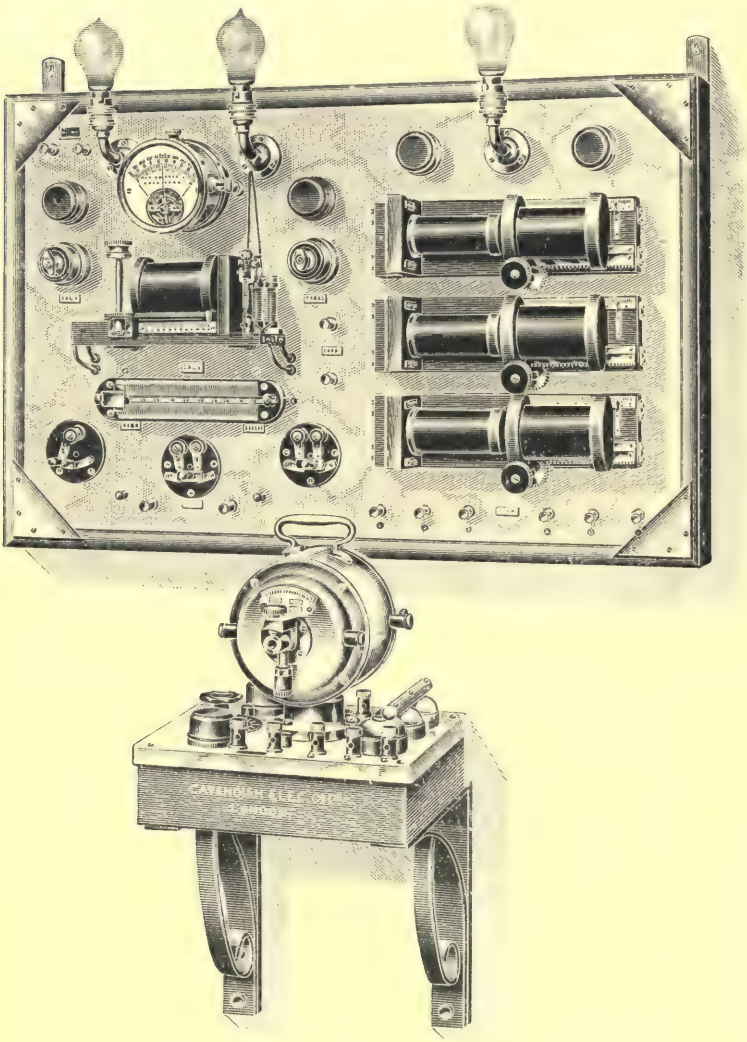


FIG. 179.—POLYPHASE SWITCHBOARD WITH MOTOR.

of the intestines and contractions of stomach, and generally exerts a powerful stimulant action on non-striped muscle. He finds these currents of great value in the treatment of

neurasthenia and gastric myasthenia, and in cases of constipation has achieved most brilliant results.

Reginald Morton has also lately drawn attention to the great value of triphase sinusoidal currents in atonic conditions of the stomach and intestines. An intragastric may be combined with a rectal electrode, and an external plate or pad applied to the epigastrium. The patient may in this way be at once treated for gastrectasis, and the constipation which so frequently accompanies it.

The sinusoidal current is an extremely pleasant and useful application, either in small local baths or the full electric bath. It resembles the faradic current, but the interruptions are smoother and much less painful to the patient. By means of these baths, various spastic and other paralyses can be conveniently treated. The current appears to lessen the late rigidity sometimes seen after hemiplegia.

The Four-Cell Bath.

This is one of the most valuable pieces of apparatus in the field of electro-therapeutics. It consists of a strongly built chair, partly oak and partly iron, fixed to the ground preferably. There are four porcelain pots or vessels, two large and deep for the feet, and two longer and shallower for the hands and arms. Into a slot in each is introduced a fair-sized carbon electrode connected up with a switch-board or with the multostat. The multostat is preferable, as it is quite earth-free.

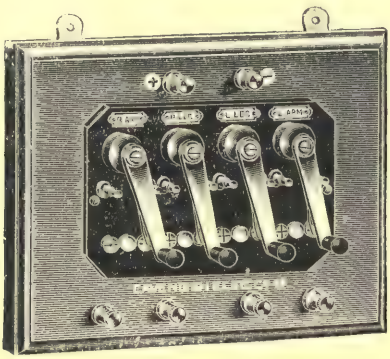


Fig. 180.—Special Commutator for a Four-Cell Schnee Bath.

Split cords connect with the main and a cleverly devised commutator, by use of which the current may be sent in various directions, such as from arm to arm and leg to leg, or from arm to leg, right or left, in, as the inventor claimed, fifty different ways. We cannot claim to have used all fifty, but have used it on many occasions and for all varieties of disability.

It is greatly to be preferred to the general hydro-electric bath, where there is such great wastage of current. A certain amount, indeed, will take place even in this bath, but it is materially less.

Every type of current may be used—the galvanic-faradic combined, or sinusoidal. It is extremely convenient for ionic treatment. In sciatica, for instance, we allow the

patient to sit on a large pad connected with the negative pole and soaked in 2 per cent. sodæ salicylate, while the foot is in one of the pots connected with the positive pole. Arms and hands may be treated similarly, *mutatis mutandis*.

The intensity of the current is capable of being regulated and measured with considerable exactitude. The patient

FIG. 181.—THE SCHNEE FOUR-CELL BATH.

need only partially undress, divesting himself of shoes and socks and his coat and vest at most. Many people find the erect posture preferable; the arms are supported and in a comfortable position, and the whole chair is capable of considerable adjustment.

The strength of current employed will vary very greatly with different patients and different affections. In ionizing

a sciatica we may rise to 50 milliamperes or more for thirty to forty minutes.

As a general tonic measure we use either the combined galvano-faradic current or the sinusoidal; the latter is

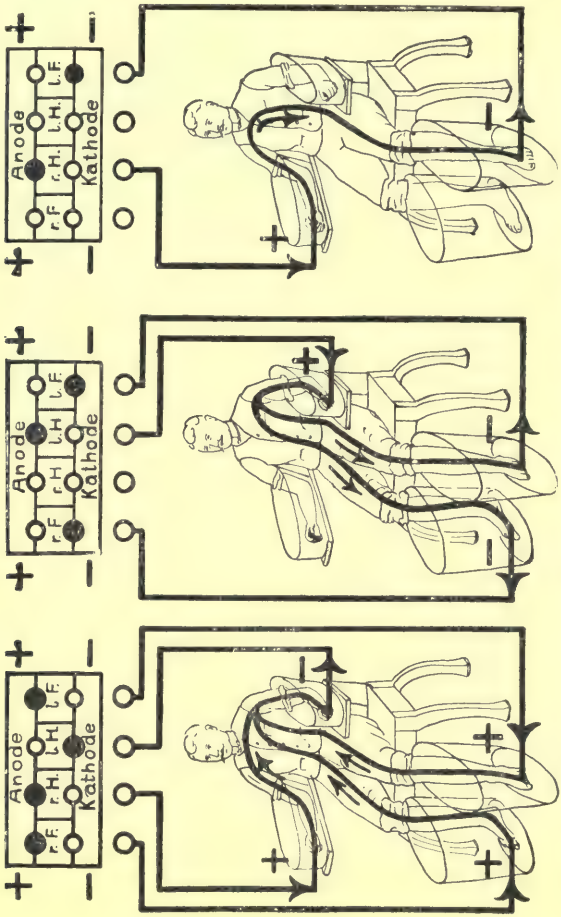


FIG. 182.—DIAGRAMMATIC REPRESENTATION OF VARIOUS APPLICATIONS OF CURRENT IN SCHNEE BATH.

perhaps the more pleasant, and there is not the same tendency to irritation around the skin at the surface of the water as is the case with galvanism. A red line is usually found after a treatment lasting any time. Glycerine or liquid paraffin poured on the surface tends to prevent this.

Patients must be warned not to attempt to stop the bath

by withdrawing hands or feet if the current seems too strong. The attendant has to stand by, and the current, of whatever kind, must be gradually turned off by adding resistance with the galvanic, or withdrawing the primary with the faradic, or moving back the secondary with the sinusoidal, or slowing the motor if we are using a multostat. Sudden withdrawal may cause a severe shock, so unpleasant as to "put the patient against the treatment" for a considerable time, if not permanently.

The General Hydro-Electric Bath.

This is still described in some of the textbooks, but we consider it is a form of treatment which might with propriety be abandoned. Some authorities have estimated the amount of current which passes through the patient's body as one-eighth of that which passes through the water itself. Wilfred Harris puts it as high as 1 in 3, but even he points out that to send a current of 50 milliamperes through a patient we shall require to keep one going of at least 150 milliamperes.

There is thus great wastage, and as it is well known that the ohmic resistance of the human body varies very greatly with the individual, we can really have very little idea of what the patient is getting at any time. A further serious drawback to this type of bath is that during the whole time the current is going the patient is immersed in warm water, which rather undoes the tonic effect of the bath by its enervating influence. If it is allowed to cool again, he is liable to get a chill.

We can certainly recall cases that improved with the bath, but taking the current wastage and indefiniteness of the dose along with the very real risk of earth currents and shocks by which a number of people have been killed, we think the bath may be quite well relegated to the scrap-heap, and the much superior four-cell arrangement be employed.

CHAPTER III

X RAYS AND THEIR PRODUCTION

The discovery of X rays by Roentgen in 1895 has been mentioned above in connection with the periods of electrical development.

Radiography hardly comes within the range of physiotherapy, being largely diagnostic in character. We are only concerned with it in so far as radio-therapy is concerned, and that in itself has become so highly specialized a subject as to be almost beyond the range of this volume.

At the same time, the outfit required for electro-therapeutics is so interconnected with other treatment, such as high-frequency, that it is essential that anyone working at electro-therapeutics has a sound grasp of what, for instance, is meant by an X-ray installation.

It is therefore incumbent upon us to describe without any unnecessary elaboration the basic elements of an X-ray equipment.

What are X rays ? They are radiations propagated with the velocity of light and the Hertzian waves with a wavelength much shorter than the ultra-violet rays. There is a graduated scale for them, just as there is a scale for luminous rays for the spectrum. Roentgen during the course of his researches for the invisible light rays turned on the low-pressure discharge tube which he had enclosed in stout black paper. Greatly to his surprise, a fluorescent screen which he had some 9 feet away shone out brightly. The light-tight black paper precluded this being due to ultra-violet rays—plainly it was due to some other type. He found that interposed obstacles or objects cast shadows on the screen, and so traced back the rays, which he called X rays for want of a better name, to their source. They

emanated from the region of impact of the kathodal rays on the glass walls of the tube.

Like many other wonderful things in medicine and science, X rays have a composite origin. Crookes invented the Crookes tube, of which the modern X-ray tube is but an elaboration. What is a Crookes tube? It is a glass 6 inches in diameter with platinum wire electrodes fused into the opposite walls of it, so that the wire projects into the tube, leaving a space about 3 inches between the two ends. A nozzle in the side of the tube is made and connected with the air pump, so as to enable us to exhaust the air. If we now connect one wire outside with the anode of a 12-inch coil and the other with the kathode, we can observe the changes in the character of the discharge as the tube is exhausted by the air pump.

In the first place, if we have not pumped out any air, the discharge is precisely similar to what takes place between the anode and the kathode across the air gap of any coil, the resistance offered being practically the same. If we set the pump working and reduce the air to $\frac{1}{1000}$ of an atmosphere, we make what is called a Geissler tube. The resistance between the terminals is now greatly reduced; we observe no sparks or noise in the discharge, but a beautiful stream of blue light stretching from the kathode to the anode. Every student of physics has seen the experiment done long before X rays were known. The stream may be deflected by the demonstrator's finger, causing the glass at the side on which it impinges to fluoresce. The stream of blue light is called a kathodal beam, and is of the nature of fluorescence excited in the rarefied air by the passage of an invisible stream of particles from the kathode to the antikathode, known as the kathodal rays. The particles constituting them are probably atoms of hydrogen gas travelling from pole to pole at the almost inconceivable velocity of 20,000 to 50,000 miles per second. The kathodal stream consists of negatively electrified electrons, probably less than $\frac{1}{1000}$ of the bulk of the hydrogen atom, the smallest chemical weight known. The beam differs from the X rays in that the latter cannot be diverted from their course by a magnet and do not consist of electrons. They are rather

a special form of pulsating vibrations in ether set up by the impact of the beam of electrons in the kathodal rays upon the object which they strike—*e.g.*, the side of tube or antikathode. X rays are also quite invisible and cannot be polarized.

Kathodal rays form the whole basis of X rays, the whole theory of which revolves around them. We turn a glass bulb into a Geissler tube and then into a Crookes tube by further exhaustion until we have produced a vacuum of less than $\frac{1}{1000000}$ part of an atmosphere—a very high vacuum indeed.

In doing so, after first reducing the resistance of the tube to the passage of the current, we actually raise it until it is much greater than when the tube was full of air. The degree of resistance which exists is estimated by the use of what is known as an equivalent spark gap. We connect an X-ray tube in parallel with a variable spark gap, and note the length of the gap when the spark, so to speak, prefers to jump across it rather than take the line of the tube; at that point we have the equivalent spark length of the tube and a definite measure of the resistance to the passage of the current. A tube exhausted to $\frac{1}{1000000}$ of an atmosphere has a resistance equal to a 2-inch spark gap approximately. By further exhaustion we can run up to an 8-inch spark gap, the limit being reached with complete vacuum when no current passes whatever. The explanation of this is a very technical matter, rather in the range of pure physics than in practical X-ray work, and does not, therefore, particularly concern us, but on a clear perception of the underlying principle will depend our proper understanding of what are called soft and hard tubes, and so on.

When the current is passing through a Crookes tube from simple wire electrodes very little is seen—kathodal rays are there in plenty, but are quite imperceptible; they pass to the inner surface of the tube, and there originate the X rays, which are again invisible, as stated above. What we do see is the greenish fluorescence of the tube where the kathodal stream strikes the glass. A certain amount of heat is produced as well by the kathodal rays, and if they

are focussed in any way the heat may melt the glass. Their impact is the cause of the generation of X rays, whether they strike the tube walls or the antikathode. The greater the vacuum, the greater the velocity of the kathodal rays and the more penetrating the X rays produced.

The kathodal rays are focussed on the antikathode by putting a small concave aluminium disc on the end of the kathode, and this is the embryo or basis of the focus tube.

The Production of X Rays.

We must submit the following postulates: (1) A supply of electricity; (2) some means of transforming the current to a high intensity, such as the step-up transformer; (3) an X-ray or focus tube.

We may add many elaborations for photographic work, but little more is needed for radio-therapy. Certain accessory apparatus is, however, needed to render the current for the tube suitable for the purpose, and to regulate the quantity.

As stated elsewhere, in most large cities the current is

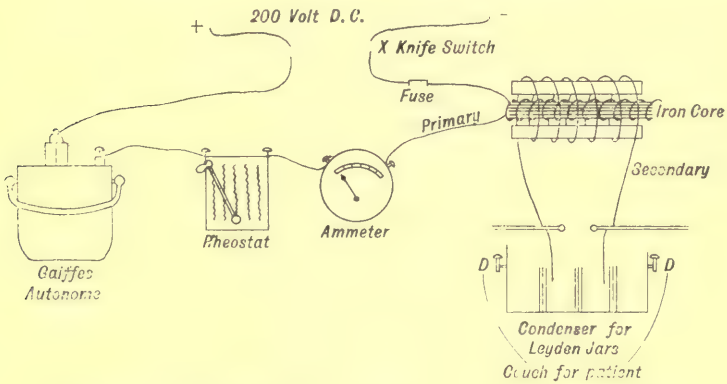


FIG. 183.—DIAGRAMMATIC SCHEME OF X-RAY APPARATUS.

high voltage and alternating in character, requiring transforming at substations. For a private supply we can generate by an ordinary gas-engine plant, which can be

used to drive a dynamo of $1\frac{1}{2}$ to 2 horse-power with a mercury break, or one of 3 to 4 horse-power with an electrolytic break.

It is desirable to have a battery of secondary storage cells, and one of twenty-seven cells of 75 ampere-hours will suffice; this will require charging up every week or ten days.

The X-Ray Outfit.

A very compact and excellent type of X-ray apparatus is figured below. It is one very largely in use at the present

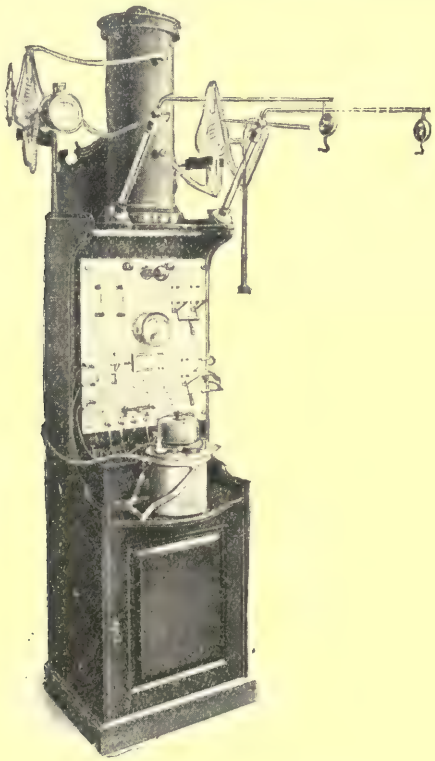


Fig 184 — Complete X-Ray Apparatus.

time. The apparatus is so mounted and the high-tension wires so arranged that accidental shocks to the patient or operator are extremely unlikely or impossible.

From the top of the discharging pillars or the spark gap two aluminium rods about 2 feet in length project, terminating in two spring rheophores, each containing 72 inches of metallic flexible conductor, which is carried to the X-ray tube itself. Slight tension is always kept up in this by means of springs, the tension applied keeping them apart and taut, thus reducing the risk of sparking to the patient or apparatus to a minimum. The operator can also work on either side of his patient or switchboard without coming into contact with the wires.

The parts of the apparatus are as follows:

1. The switchboard fitted with a double-pole main switch, double-pole fuses and pilot's lamps, amperemeter, rheostat for motor and transformer, and main supply terminals.

2. The coil of Rochefort-Gaiffe type, sectional wound.

3. Interrupter of gas-mercury type (autonome).

4. The spintermeter, controlled by rack and pinion adjustment.

5. Valve tubes are of Pilon type, with supports of red fibre.

6. Milliamperemeter of the dead-heat d'Arsonval type, with a protective condenser to prevent injury from internal sparking.

The X-Ray Coil.—One might describe the X-ray coil as the backbone of an X-ray outfit. If a doctor tells us he is doing radiography, the first question that suggests itself is, What sort of coil have you got — 12-inch, 16-inch, or 18-inch ?

The X-ray coil is really but an elaboration of the Rhumkorff coil of our physics days (fully described under Faradism), but it is much more powerful with a very much longer secondary winding. It may run to a mile or considerably more of fine wire. Briefly, the essential parts are—

(1) The primary coil, which consists of a number of thin rods of iron, round which are passed numerous turns of copper wire. This is insulated from the secondary coil by being placed inside a vulcanite tube.

(2) The secondary coil is much more elaborate, and consists of a very great number of turns of fine copper wire

wound in a number of sections vertical to the plane of the coil.

The E.M.F. or spark gap to be obtained increases with the number of turns used, or, in other words, with the length of the secondary coil. Thus we can transform a primary current of 200 volts to 50,000 or even 100,000, but the number of amperes is reduced in the same proportion. The amount of energy is never increased, as this would be contrary to a physical law; and not only so, but, on the contrary, a certain amount of loss is incurred in the transformation from one potential to another.

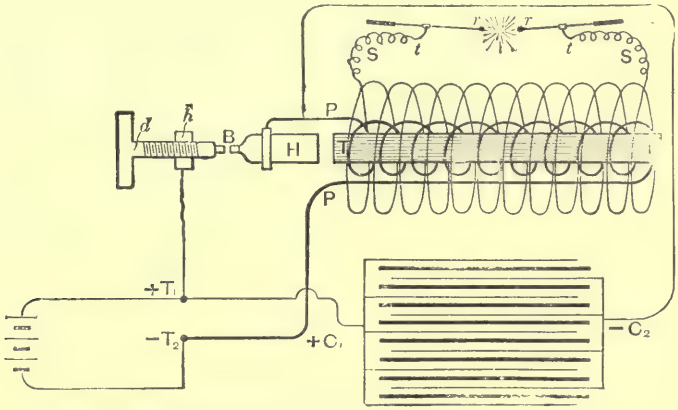


FIG. 185.—RUHMKORFF INDUCTION COIL, SHOWN DIAGRAMMATICALLY. (WILLIAMS.)

The **Condenser,** a very important part of the coil, lies usually in its base; it is absolutely necessary when a mercury break is being used. It is connected in parallel with the interrupter, and helps to reduce the spark appearing in the interrupter on breaking the primary, and also tends to demagnetize the core rapidly. It is not called for if a Wehnelt break be used.

The condenser consists of a number of sheets of tin-foil insulated from one another by sheets of waxed paper.

The above diagram will give a rough idea of the working of the coil condenser, etc. The current passes from the positive pole of the battery or the main by *TX* to *d*, the adjusting screw, and thence through the platinum con-

tacts b and the primary winding P back to the negative pole T_2. The circuit is completed, and the core T becomes magnetized, the hammer H is attracted, and the platinum contacts pulled apart, thus breaking the circuit. All this is familiar to those who recall the physiological physics.

The core then becomes demagnetized, and the platinum contacts are pulled together again by means of the brass spring, contact being made; the iron core is again magnetized, and so on *ad infinitum*. C represents the condenser, with the thick lines representing waxed paper and the thin ones tin-foil. When the contact at B is broken, the current passes into the condenser, and tends to hasten the demagnetization of the core.

The E.M.F. of a coil or the spark length depends to a great extent on the number of secondary windings. Every coil is provided with sparking pillars, one being a point and the other plate-like in form. The object of these is the detection of polarity. When the plate is the negative pole, sparks discharge easily to any part of the plate; when the point is negative, on the other hand, sparks will discharge to the point from the edge of the plate. The passing of the current through the primary coil sets up a magnetic field, and this, as well as its disappearance, induces currents of short duration in the secondary coil, their strength depending on the intensity of the magnetic field and the suddenness of its appearance or disappearance.

With regard to coils, a very important point to remember is that for radiography, and specially for instantaneous work, powerful coils of 18 to 22 inches are required, but for therapeutic work, with which we are here alone concerned, smaller coils of 10 to 12 inches suffice admirably.

The Switchboard.—The coil is controlled from the switchboard. This is usually fixed to the wall of the room or on a special stand, and is of black slate or marble. It is provided with all the necessary switches, fuses, and terminals, and a signal lamp to show when the current is on. There is a switch and rheostat to control the speed of the interrupter, and an ammeter by which to record the primary current.

The X-Ray Tube.—The X-ray tube is, after the coil, the most important element in the equipment for X-ray work. Initially consisting of a glass sphere, the X-ray tube has become somewhat more complicated from the addition of various horns or windows for one purpose or another. In the manufacture the electrodes and terminals have to be placed in position, the tube exhausted and annealed. Great care is needed in this process, and much time often expended.

The various parts of the tubes are depicted in Fig. 186. The antikathode calls for much care and consideration. In the better type of tube it is a very solid, heavy one, made of copper or nickel fitted with platinum, and for very heavy work tungsten. The capacity of the tube to stand a heavy current depends largely on the weight of metal used. There is a great tendency for the antikathode to get hot during the running of the tube, especially if a heavy current be used, and this is combated by various devices. One is the Cyclops tube, in which the copper portion of the antikathode can be exchanged by withdrawal during the time the tube is in use. The other and more commonly employed is the water-cooled tube, in which the back of the target is practically immersed in water, for which there is a special extension blown.

Such tubes may be used for hours without getting heated, and so "softened."

In connecting up the tube it has to be remembered always, as mentioned elsewhere, that the kathode or concave aluminium terminal is connected with the negative pole of the coil, and the antikathode with the positive. Neglect of this precaution will damage the tube and make good work impossible.

Hard and Soft Tubes.—Heating of the target and prolonged use of a tube tends to make it soft, as it is called. That is, the vacuum is lessened and the tendency to burns is greatly increased. Gases are released from the glass and the vacuum so reduced. Rest and cooling of the tube will so far remedy this, but failing that a small current of, say, $\frac{1}{2}$ to 5 milliamperes should be passed for a quarter to half an hour until the required vacuum is attained. On the other hand, if the tube is hard the vacuum may be lowered

by running the current the normal way for ten minutes or so, or by use of the device known as an osmo-regulator, a small palladium tube projected through the neck of the bulb. This metal has the curious faculty of allowing hydrogen to pass through it while it is hot by a process known as osmosis. Therefore, if it is made incandescent by means of a match or spirit-lamp, the vacuum can be reduced by means of hydrogen gas. Before using the

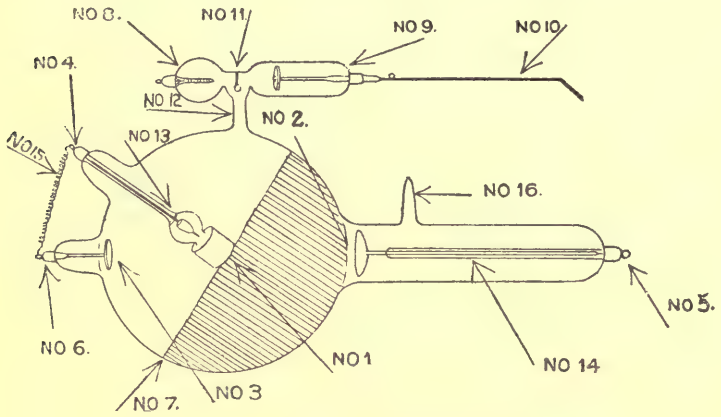


FIG. 186.—CHART OF AN X-RAY TUBE.

1, Antikathode or anode surface; 2, kathode surface; 3, anode or accessory anode surface; 4, sealing-in point and cap of antikathode; 5, sealing-in point and cap of kathode; 6, sealing-in point and cap of anode; 7, hemisphere of X ray; 8, heightening device on regulator or auxiliary antikathode; 9, lowering device on regulator or auxiliary kathode; 10, movable swivel on regulator; 11, wall between universal regulating device; 12, connection between main bulb to regulating device; 13, glass rod back of antikathode; 14, glass rod back of kathode; 15, wire between antikathode and anode; 16, exhaust tip.

X-ray tube again the osmo-regulator must be allowed to completely cool.

Another form of regulator is the mica type, in which some mica or carbon having the capacity for releasing gases is kept in a small sealed cylinder communicating with the tube. By means of special terminals for regulating, current can be passed through this and the mica heated.

The rays of soft tubes are of low penetrative power, and

the tube does not require a very high E.M.F. to work it. Hard tubes, on the other hand, require very high E.M.F.,

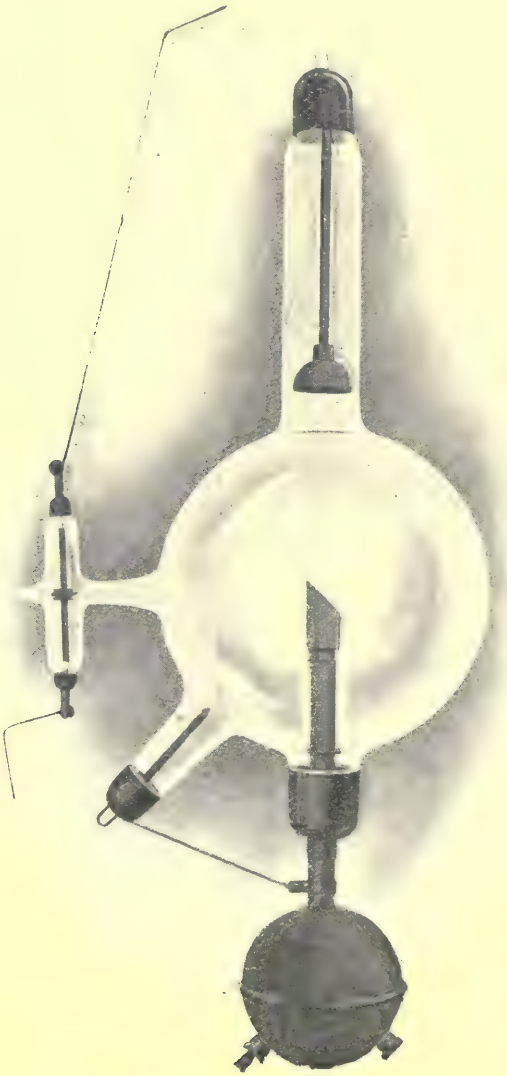


Fig. 187.—Modern Type of X-Ray Tube.

being very resistive to currents passing through, and the rays are highly penetrative. With the harder types of tube even bone becomes transparent.

All these points are of more or less photographic or radiographic than therapeutic interest, but must be grasped to comprehend the working of an X-ray outfit.

The operator requires to remember that it is of the greatest importance to connect the tube properly with the induction coil, or its life will be short. The antikathode has two functions—(1) it is the active anode of the tube as well as (2) the target which the stream strikes. It must be always connected with the positive pole of the coil. Similarly, the kathode requires to be always connected with the negative pole. This having been done and the current switched on, the current enters the tube, leaving at the kathode.

The kathodal stream initiated on the concave aluminium surface of the kathode is then discharged with tremendous velocity, as above mentioned, and brought to a focus near the centre of the antikathode. Here the X rays are generated and discharged in all directions after the manner of the ribs of a fan. Though they are themselves invisible, they yet cause a very marked fluorescence which lights up the whole of the tube in front of the antikathode. A sharp plane of differentiation between the light and dark zone (behind the antikathode) is at once noticeable. Irregularity in this respect is due to the wrong connection, or what is called reverse current.

If the former, the current must be switched off and reconnection made properly. If the latter, it is less easy of remedy, but the proper course of action will be described later. Perfection is not always reached without practice, needless to say.

Any change will at once be noticed, for the vacuum falls so as to make the tube uselessly soft; therewith a display a purple or violet fluorescence which will cease altogether when the tube acts as a spark gap. If the vacuum becomes higher the characteristic fluorescence is *yellow* more than green, and with very high vacuum no current will pass at all; fluorescence again ceases, and sparking all over will take place. The storing of tubes requires some care, as they are not very easy things to handle and put away. They should be under cover of some sort to keep the dust

away, or kept on perforated shelves with the holes padded and large enough to pass the kathode stem through. If a number are in use, it will be convenient to have shelves for the three grades—hard, soft, and medium.

It has been pointed out that every tube has its appropriate current: what Schall calls the normal current for it. It may be defined as the amount of current that will keep the degree of vacuum constant. This is done by only as much gas being liberated from the antikathode as can be taken up by the tube walls. The operator is kept right so far in regard to this if he always has, as he should have, a milliamperemeter in the tube circuit.

If we start off, say, with 1 milliampere passing and sudden rise occurs, the resistance has plainly been lowered from some cause, and the current must be reduced or cut off. If the indicator falls, then the resistance must be rising, and the vacuum should be reduced. With a new tube it is quite enough to start with a $\frac{1}{2}$ milliampere current and gradually raise it to 3, which will quite suffice for all therapeutic purposes. The tube requires a certain amount of seasoning always. In instantaneous photography of the lungs or heart, of course, it is customary to send a very heavy current through, with as much as 50 or 100 milliamperes for $\frac{1}{50}$ of a second. While tubes do burst at times under this strain, it is less likely to do harm than a current of 10 or 15 milliamperes for a few seconds.

The range of current we can use depends largely on the tubes employed, but it varies from 2 to 5 milliamperes. We seldom exceed 3 milliamperes, however, and for a small tube 0·5 is ample.

The lifetime of an X-ray tube depends on a variety of factors, but none of them last indefinitely. The tendency is for a tube to become hard—in other words, for the vacuum to be so complete that it is next to impossible to send a current through it.

The terms hard, soft, and medium, are regularly used in describing tubes, and they at once indicate the degree of exhaustion of the tube, the resistance opposed to the passage of the current, and the degree of penetrating power of the X rays produced.

It has been suggested that as a tube is used its vacuum becomes higher, owing to particles of gas being forced into the glass as a result of the tremendous velocity at which the hydrogen electrons travel. This is, of course, a matter difficult of proof, and is largely pure theory.

Back electro-motive force or reverse currents tend to shorten the life of a tube, as small particles of platinum are torn off the antikathode, and these absorb gas in the tube. This is why we have to be very careful to watch the connecting up of the tube at the start, as a few minutes with the current going the wrong way will spoil a tube.

Overuse of a new tube, which is usually soft, will spoil it, as it will make it more soft still, and the rays are then of such low penetrative power as to be useless. A heavy current passed through a tube will very soon heat the antikathode, and even melt it, and this, of course, finishes the useful career of the tube. This can be guarded against by noting when the antikathode gets red, and then cooling off by stopping the current. Occasionally perforation of a tube will spoil it, and this, it may be said, is an accident which will happen "in the best regulated families." It is more common in a hard tube than a soft, and may be due to conducting wires getting too near the tube and causing a cross spark.

Reverse Currents.—Reverse current has been mentioned above; it is in many respects the *bête noire* of the radiologist. These currents cause a deterioration of the tube, as the platinum of the antikathode becomes disintegrated gradually and is deposited in the form of grey dust on the wall of the tube, which becomes hard and useless. They further lead to the production of secondary rays, which tend in radiography to make the photos foggy and ill defined.

Reverse currents are, in point of fact, induced currents such as are generated in an ordinary du Bois Raymond coil. The current induced on breaking the primary has the same direction as the inducing current, and that induced on closing has the opposite direction. It is called the reverse or closing current.

Apart from the inconvenience in photography, reverse current makes the reading of a milliamperemeter difficult

and inaccurate. Every effort is made, therefore, to suppress or minimize it. To this end valve tubes and mechanical rectifiers are used with more or less success, being placed on the secondary circuit. The principle underlying all these devices is to interpose a maximum resistance to the reverse current, only allowing the normal or unidirectional current to pass. For this purpose we use a valve tube such as Pilon's, or more seldom now the spark gap. The working of the latter is based on the fact that the voltage of the reverse current is considerably less than the normal or direct current. It is therefore arranged to interpose enough resistance in the circuit to choke off the reverse current while allowing the stronger current to pass. For this we use a mica plate and point spark gap, the positive pole being connected with the point. The current passes much more easily from the point to the plate, but even if there be a small gap the reverse current may pass.

In the mechanical rectifier we arrange to insure that at the moment of making the primary current the secondary current is kept open by interposing a large spark gap, which, however, ceases the moment the primary current is broken.

CHAPTER IV

HIGH-FREQUENCY AND SINUSOIDAL TREATMENT

We can best understand the nature of the currents employed if we consider the action of the Leyden jar. It is well known that when a discharge takes place the spark does not represent a single exchange of the exact amount required to equalize the electric conditions of the two armatures. Equilibrium is only reached at the rate of about $\frac{1}{4}$ million discharges per second, and the relative condition of the two armatures undergoes this number of alterations per second; if the human body be connected with the armatures, the application differs entirely from faradism and galvanism. While the amperage is very low, the voltage is very high. With the best types of high-frequency machines the current runs up to 1,500 or more milliamperes, and with some types suitable for diathermy up to 4,000 milliamperes. Of course, nothing like this can be obtained even from the most powerful static machines.

Source of the Current.—Any source of high-tension current can be used, but a coil or alternating current transformer is preferable to a static machine; for useful work a 12-inch coil is needed. Using the direct current with a coil of this size, we have found Gaiffe's or Bondel's gas-mercury break most satisfactory. The special advantages claimed for it with some reason are:

1. Great amperage—the amperage ranging from 20 to 50 amperes at a pressure of 220 volts, a flame passing between the secondary terminals similar to that with a Wehnelt break.

At that voltage the average break passes very little above 10 amperes, with the result that the spark is thin and greater exposure required in radiography. The principle on which this heavy amperage is passed is that of multiple contacts,

the number of interruptions per minute reaching 6,000 and over. This interrupter is generally arranged to operate

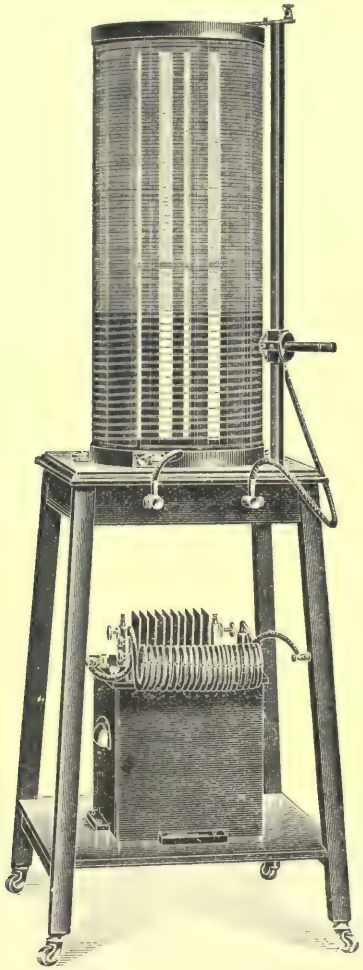


FIG. 188.—OUDIN'S RESONATOR AND OIL CONDENSER.

with ordinary coal-gas as the dielectric, and the best results are so obtained rather than with spirit used in some types.

2. The interrupter is capable of very considerable adjustment, either for feeble currents suitable for therapeutic work, or powerful currents required for instantaneous radiography. The driving speed is adjustable from a low minimum to a high maximum number of interruptions per second. There is freedom from danger of short circuit, because when the break stops contact is broken. The break can be run independently of any current through the primary winding—*i.e.*, once the break is started the primary current can be switched off or on without the interrupter being stopped or restarted. It is very quiet running, contrasting very favourably in this way with the very noisy Wehnelt.

With all this admitted, we have to say that the perfect interrupter has yet to be discovered, and we have had a good many mornings' work spoiled by a breakdown in the autonome. This, it must be admitted, was due usually to want of cleaning when the interrupter had been in very steady employment. Cleaning is an ordeal postponed as long as possible, but usually has to be done every four or five weeks to keep the machine in good order. A good deal depends on the gas used as dielectric, for if it is rich in carbon the choking-up occurs sooner. The carbon frequently chokes up certain holes in the mechanism, and a piece of wire or a pin are needed to clean it out. The mercury requires turning out and filtering through a piece of chamois leather. This is a dirty, "messy" sort of business, and is preferably done by a mechanic assistant.

The autonome is a very neat and easily carried about piece of apparatus, and the appearance of the complete machine may be seen in Fig. 189. As regards the connections, the upper portion is screwed into the vessel V by the screws e, e. The terminals I^1, I^2, and I^3 are connected with the corresponding terminals of the switchboard. M is a vulcanite cap covering the motor driving apparatus. To use the interrupter we connect the gas-supply tube with the tap R, care being taken that the gas-supply is higher than the motor tap, so that the tube does not sag or kink or the mercury be thrown back into the rubber tube and so check the pressure of the gas. Open the inlet tap R

and the outlet tap R^1, and turn on the gas, and then put a lighted match to R^1.

At first air is driven out only, then gas and air, and then pure coal-gas burning with a yellow flame. The tap R^1 may now be closed, and the interrupter is ready for use. The vulcanite spindle B is given a whirl with the hand, and if the current be on in the motor circuit the interrupter will run smoothly. The current passes through the body of

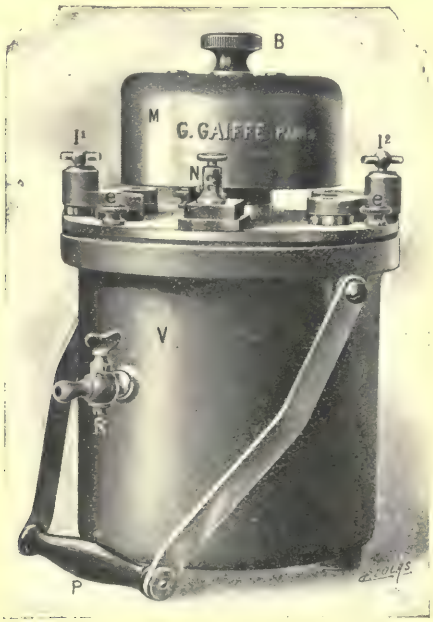


Fig. 189. The Autonome or Gas-Mercury Interrupter. (Gaiffe.)

the cone C, the mercury being thrown out in small jets through the four holes marked b against the tooth d, and through the motor winding.

No current passes through the primary circuit of the coil until the turnover switch on the board is turned to normal. The current then passes through a second tooth on the side of the break opposite to d, and through the primary circuit. When the switch is put to the intensive side the current passes via another peculiarly constructed

contact, which immediately doubles the rate of interruption with the same mechanical speed of the motor, part of the interrupter thus giving a very large output in the secondary circuit.

This apparatus, when used in conjunction with the high-frequency d'Arsonval couch, can easily pass 1·5 amperes when holding the two-handle electrodes by the hands; if, however, other electrodes be connected in parallel, currents as high as 4 amperes can be obtained and a general glow established all over the body.

Effleuve Effects.—These are obtained by means of the Oudin resonator, which can be supplied mounted with the apparatus as in Fig. 188, or standing separately. It consists of a helix of bare copper wire wound round an insulating cylinder with a sliding contact, to permit of obtaining the condition of electrical resonance in order to produce long and soft effleuves without tendency to spark discharge. The coils of wire between the lower end of the helix and the movable point form part of the oscillating circuit, which includes the condenser and spark gap; the upper end is the one to which the effleuve brush is connected when the unipolar treatment is given. In the bipolar treatment the effleuve brush is connected to the lower end, and the patient may hold an electrode which is attached to the upper end; the former, however, is the most favoured and generally the most pleasant form of treatment. The resonator modified by d'Arsonval has also found favour with some workers. We have an air-cored transformer with primary of a few turns which forms part of the oscillating circuit, including condenser and spark gap, but no direct metallic connection between it and the secondary, which is composed of a large number of turns wound on an insulating cylinder, generally vulcanite. In the bipolar treatment the primary is placed in the middle of the secondary, and the patient connected to one end by holding a metallic handle, whilst the effleuve brush is connected to the other. Here, again, the unipolar method is most pleasant, presenting no tendency for faradic sensations, and is attained by sliding the primary to the end of the secondary and coupling the two circuits together by

means of a wire. The intensity of the effleuve discharge may then be regulated by moving the primary from one end to the other of the secondary. For intense discharges in the vacuum electrodes both the Oudin and d'Arsonval type give excellent results when used in conjunction with the oil condenser and multiple spark gap.

High-Frequency.

The **Coil** used is of the usual type, as employed for X rays (which see, p. 352).

If the current available be of the alternating type, then the interrupter described there will require to be replaced by one equally simple in operation and of similar appearance, but differently arranged internally.

We require a table, as figured below, with a large 6-inch dial hot-wire milliamperemeter dead-beat with zero adjustment.

A silent spark gap, or spintermeter (Fig. 191), is now used, comprising nine gaps entirely closed and requiring no cleaning. The spark takes place between silver contacts across a gap of a few milliamperemeters, with no noise beyond a slight hissing sound. This is a distinct advance on the globe spintermeter, which was noisy and sometimes disturbed nervous patients.

On the lower shelf of the table is a condenser consisting of a special vulcanite tank with special glass plates separated by tin-foil and immersed in petroleum oil, which acts as the dielectric.

All effleuve effects are enhanced by the use of the **Oudin Resonator.** This consists of about 200 feet of copper wire wound helical fashion around a vulcanite or wooden stand. It ends at the top in a metallic knob, to which is attached the wire or lead to the electrode used for effleuve or other local treatment. The condenser—or Leyden jars, if used—is connected with the bottom of the helix, and also with a point on the surface of the wire helix which varies according to the use to which the resonator is put. The adjustment of the clip is known as tuning up the resonator. That portion of the helix lying between the attachment from the

condenser acts as a primary coil. The upper portion, acting as the resonator, may be compared to the secondary coil, and immensely increases the power of the apparatus.

A wire is usually attached to the bottom of the solenoid, and then connected to a gas or water pipe to insure an earth connection.

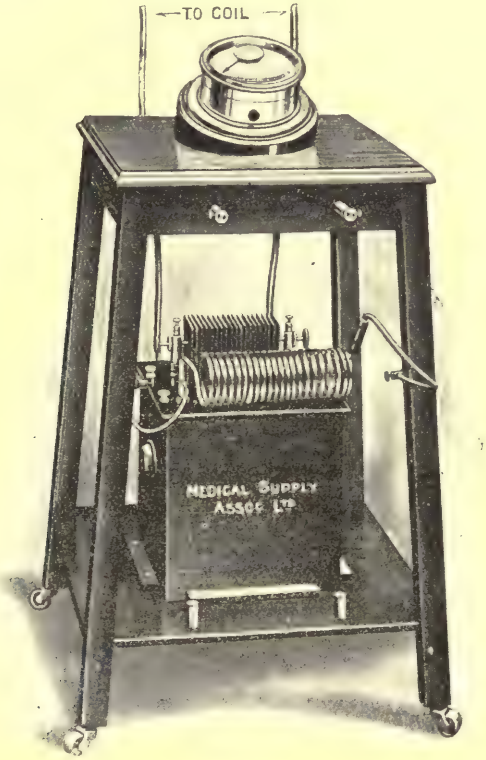


FIG. 190.—STAND WITH OIL CONDENSER AND MILLIAMPEREMETER.

The best effleuve can be got from the type of Oudin wound on an oak frame, about 3 feet 6 inches high and on a separate stand.

An alternative to the employment of this is the Tesla transformer, consisting of a primary helix of four turns of thick wire carrying the current from the condenser, which surrounds a much larger number of turns of finer wire,

which passes round a vulcanite cylinder. A space of about 2 inches lies between the larger primary coil and the secondary helix. The secondary coil can be moved in and out of the primary in the Tesla arrangement, varying the strength of the induced current. In Gaiffe's modification known as the d'Arsonval transformer the primary coil moves backwards and forwards, and attachment is made for the effleuve wire at the right-hand end of the secondary coil, where there is a special terminal for it.

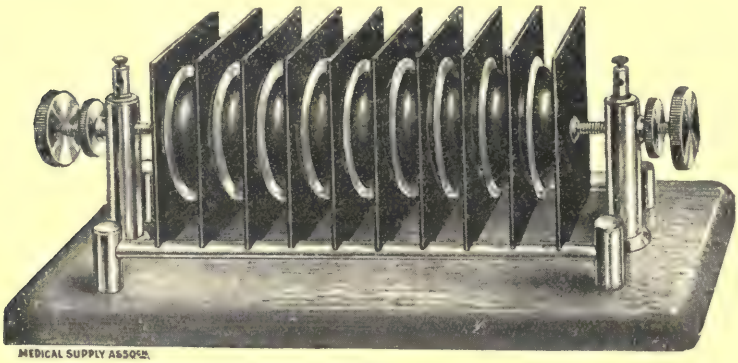


FIG. 191.—MULTIPLE SILENT SPARK GAP.
Does not require cleaning or adjustment.

These differences are little more than details in individual makes; construction and the result is much the same in either case.

Methods of Application. — 1. *Auto-condensation* on the couch is probably the most commonly employed method in general electro-therapeutics. Here 500 to 1,500 milliamperes and over are passed into the patient, who lies on the couch, really acting as one of the armatures for a Leyden jar. The other armature is represented by a large piece of zinc sheeting attached to the lower surface of the couch. The patient holds on to handles which are attached to the arms of the couch, and connected directly with the copper solenoid of the high-frequency apparatus. This treatment is very soothing to excitable people, neurotics, etc., and favourably influences cases of neurasthenia with associated hyperpyesis. Local treatment of this kind may be given

by connecting up a plate of zinc, which is placed uncovered on the patient's epigastrium or part to be treated. In this case the handles are not held by the patient.

2. *Auto-conduction* is not used so commonly. In it the patient stands inside an enormous solenoid forming the secondary of a gigantic induction coil. This method has rather fallen into desuetude. The risk of cross-sparking is very considerable, and alarms nervous patients.

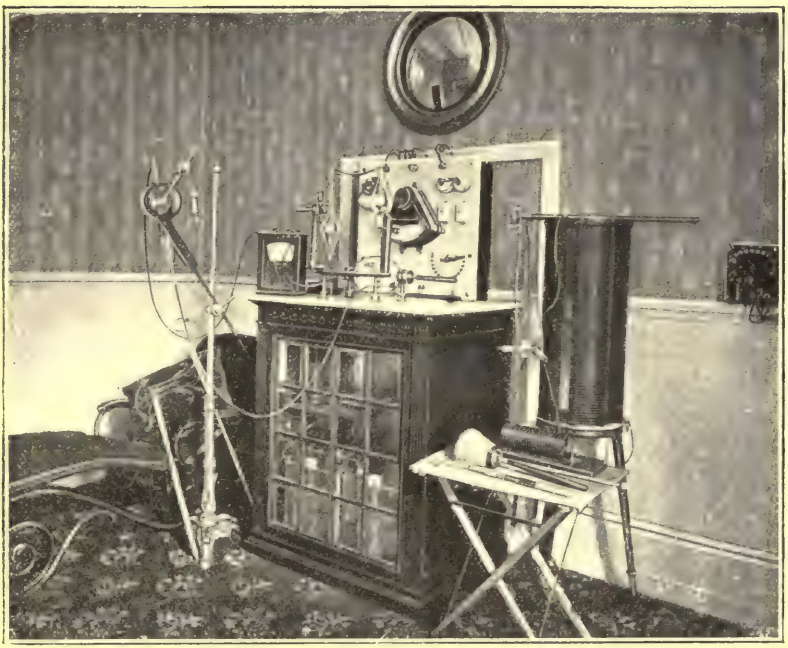


FIG. 192.—THE D'ARSONVAL-GAIFFE INSTALLATION FOR HIGH-FREQUENCY, STATIC ELECTRICITY, AND X RAYS.

3. *Vacuum Electrodes.*—Here the current is passed to the patient by means of a special form of vacuum tube fixed on a vulcanite handle, such as that of Dr. Bisserié. The tube is similar to a Giessler tube, and a practical point to remember with it is to always put it into contact with the patient before turning the current on or off. Given on the bare skin, the sensation imparted is not unpleasant, but

through clothes it is slightly painful. The area of skin treated becomes flushed, a local passive congestion being induced.

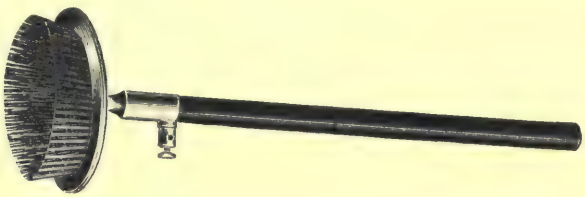


Fig. 193.—Hedgehog Pattern Effleuve Brush for applying High-Frequency Current Discharges.

It is made up of closely packed metal bristles, and very evenly cut into a dome shape, producing soft and pleasant effleuves.

The effleuve discharge is another form of treatment, and more suitable for some cases. It is entirely different from the vacuum tube in its *modus operandi*, there being no

Fig. 194.—Professor Doumer's Rectal Electrode for Treatment of Hæmorrhoids, etc.

local heating—the sensation being likened to the fall of snow. Figures of the various types of effleuve brushes are given below. It is usually administered from a resonator of the Oudin or d'Arsonval type.

Fig. 195.—Grand Model Grip Handle for Patient, so arranged that it can be used as a Single Pole or Double Electrode.

This electrode can be used for high-frequency or diathermy treatment.

Measuring the Current.—The strength of the current will depend on the width of the spark gap, but can also be graduated by regulating the current from the induction

coil which supplies the Leyden jars. Fig. 196 represents a hot-wire milliamperemeter. The strength used in high-frequency treatment will vary considerably with different operators and with the patient, but runs up as high as

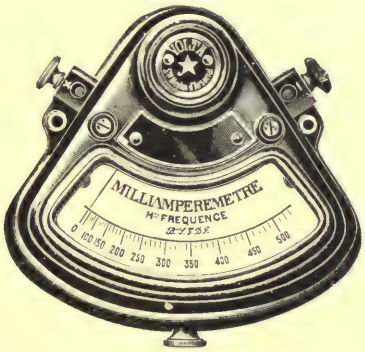


Fig. 196.—Hot-Wire Milliamperemeter.

1,500 milliamperes. In auto-conduction the full power of the machine is commonly employed, but measurement cannot be made; in auto-condensation the galvanometer is placed between the patient and his point of attachment, and in local applications it should be in series with the

Fig. 197.—Adjustable Handle of Dr. Bisserié.

By means of a sliding contact the amount of current passing to the patient is regulated. When the sliding contact is brought near to a small ball, a portion of the current is diverted into the handle held by the operator. This reduces the current of the electrode applied to the patient. This is specially useful for internal treatment.

patient. In brush discharges the appearance of the effleuve is a guide to the current strength.

Therapeutic Value of High-Frequency.— Rather extravagant claims were made for this method of treatment on its introduction about seventeen years ago; medical men became over-enthusiastic and went to extremes. The word "caught

on" with patients, and the treatment was boomed to an absurd extent. From this there was a marked and, one might say, overreaction. We can only speak from our own experience. Some of us have been in the habit of employing high-frequency for various conditions daily for the past ten years or more; during the past two years hundreds of officers with neurasthenia, neuritis, insomnia, and other conditions, have been treated by us with high-frequency, and the general results have been remarkably good. Some years ago a well-known worker in electricity told the writer he regarded a feather-bed as of much use therapeutically as a high-frequency couch. Such expressions of opinion are extreme and absurd, and merely reveal the fact that the speaker has not been working among the class of patient or variety of disease likely to be benefited, or, if so, has simply allowed himself to be blinded by prejudice. We may take *neurasthenia* as a typical condition which does unquestionably improve in the majority of cases under auto-condensation.

Let not the sceptic reply, "Such patients improve with bread pills." Dealing with the excited and worrying neurasthenic one cannot but be impressed with the way the strained look quickly disappears, the excitement goes, and at night sleep comes. Many of these people have an associated hyperpyesis or commencing arterio-sclerosis. Twenty minutes on the couch will bring the pressure down 20 mm. Hg, in some cases relieving the headache and malaise. Metabolism, where faulty, is improved, and there is an increase in the output of uric acid and urea in the urine.

The improved tissue oxidation can be made use of in the later stages of Weir Mitchell treatment, when patients are inclined to get "stuffed up," lethargic, and bilious. The elimination of waste products by the kidneys is encouraged, and the development of "a bilious attack" averted.

In various digestive disorders general d'Arsonvalization of the patient does good. We have used the gastric monopolar electrode with benefit in neuralgia of the stomach and gastric hyperæsthesia. A white metal or aluminium

electrode, 4 inches by 4 inches, is used. The skin over the part treated gets red, and may even develop papules, but the counter-irritant effect does good. Sinclair Tousey recommends high-frequency in constipation, but of that we have had no favourable experience, and prefer sinusoidal treatment. In the pain and tenderness over the colon in that intractable condition mucous colitis the vacuum tube, used thoroughly, is of very great value. It is at once counter-irritant and acts by suggestion, the neurotic type of patient being impressed by the mystery of the coloured illumination of the tube.

In cases of insomnia the treatment should be given late in the day, and appears to have a very considerable influence in inducing a restful feeling at bedtime. Doubtless the fall in blood-pressure helps in most cases. The time should not be too long—about fifteen minutes—as overtreatment aggravates the condition. A few minutes' mild application of the vacuum tube has a soothing effect also.

It would at once suggest itself that in chronic or subchronic disturbances of the metabolism, such as obesity, gout, and rheumatism, high-frequency is of value, and this we find in practice to be true. Of course, for the material reduction of obesity the Bergonie apparatus holds the field.

The effleuve or vacuum tube applied locally is very beneficial for that trying minor ailment chilblains, or erythema pernio. In cases of piles, pruritus ani, and painful fissure also, the special rectal electrode can be used with great benefit. Acne vulgaris is another affection which often yields quickly to the local vacuum tube. We have seen a case of severe *acne rosacea* greatly benefited, but, as is well known, this condition is not easy to cure.

We have experience of several interesting cases of alopecia areata and premature whiteness of the hair caused by the stress of the war, crashes in an aeroplane, and so forth, treated with the vacuum tube, with the result that the hair began to grow steadily. One case in particular was so sparsely covered that he entered hospital with his head bandaged. The cure was slow, but in a year's time he had a thick growth of good hair. In another case the colour

came back to a patient's hair, which was snow white on commencing treatment.

In neuritis we use both auto-condensation to combat the toxæmia and deficient metabolism, and the local glass electrode as a counter-irritant. The tenderness in some cases is so extreme that local treatment cannot at first be borne.

The benefit in cases of high blood-pressure before any considerable arterio-sclerosis has established itself is well known. Moutier recorded as large reductions as 40 to 50 mm. Hg. Reaction always occurs, but as a rule further treatment causes a second reduction, and the general effect is to induce a lower level. We have used it with quite a number of medical men, and demonstrated the fall by means of the sphygmomanometer to some who were inclined to be sceptical.

It will be thus seen that the field for the use of high-frequency is a very wide one—one may say wider even than that of either galvanism or faradism, except as regards diagnostic purposes.

One caution is necessary. Every few months we come across a patient who complains of headache coming on immediately after the treatment—a cephalalgia of quite a severe type. The cause or reason for the treatment bringing this on is difficult to explain or be clear about, but we have no doubt about the genuineness of the complaint. We usually stop the treatment at once.

Diathermy.

Diathermy is a form of thermo-therapy which utilizes electrical energy for the production of thermal effects in the body tissues, but is quite a new departure from the procedures formerly employed in clinical work.

These were what are known as exogenous methods—poultices, warm baths, radiant heat, and the like. In diathermy the source of contributory heat is endogenous, the heat being produced actually in the deeper-lying tissues. As regards the skin, Somerville a good many years ago pointed out that high-frequency raised the surface tem-

perature considerably—from $\frac{1}{2}°$ to 17° F. Diathermy is but a variant of high-frequency, and with it we can go further and raise the temperature of the deeper tissues to an extraordinary extent. The degree depends on the ohmic resistance and on the square of the intensity of the current. The underlying physical principle is what is known as the Joule effect, on which depends the lighting of lamps and the heating of rheostats. Electricity, when passed through a resisting medium such as a slender nickel wire, becomes converted into heat; but if we substitute the body tissues,

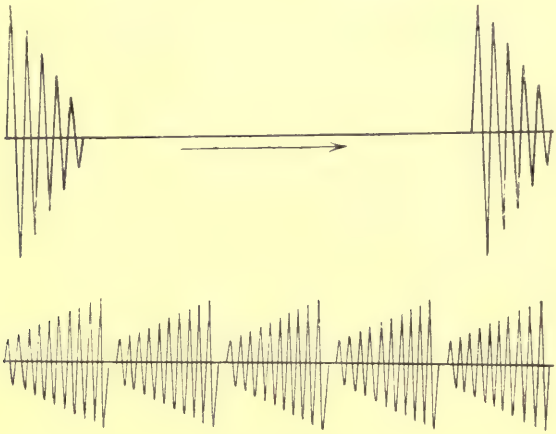


FIG. 198.

Upper tracing shows oscillations from ordinary high-frequency apparatus. Lower tracing shows oscillations from diathermy apparatus. (From the author's work on "Medical Electricity," published by Mr. H. K. Lewis.)

which form an electrolyte for the wire, the result is the same—heat is generated. If, however, the current is continuous, as in galvanism and ionic treatment, we know the effect to be largely chemical, and the amount of heat generated is relatively small. On the other hand, with an alternating current the thermal effect is practically the sole manifestation of the passage of the current. To produce a considerable amount of heat with a galvanic current we should require to use a powerful current, and the almost immediate effect would be a painful electrolytic burn. With

a purely alternating current violent tetanic spasm of the muscles would ensue.

We are thus driven back on something of the nature of high-frequency currents. With a sinusoidal current, where the alternations are 39 to the second, muscular tetanus is

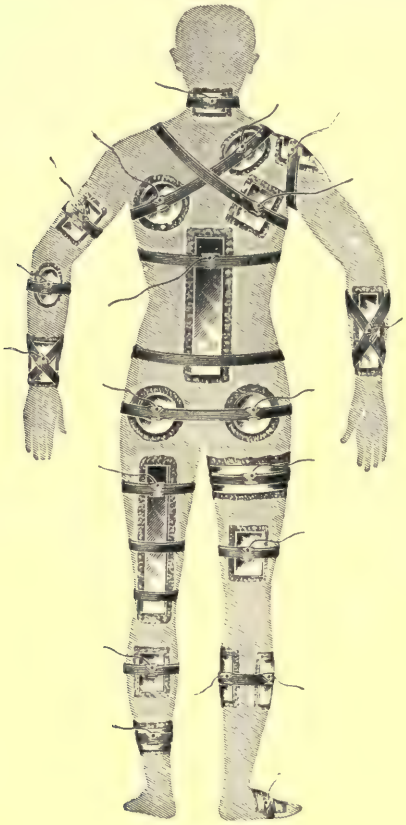


FIG. 199.

The above figure shows some of the many ways in which electrodes can be conveniently connected and supported on the body.

produced; and even if the alternations are so frequent as 5,000 per second, we may merely attain the same result. Beyond this frequency the muscle becomes less and less responsive, and does not react at all to the millions of stimuli per second which are produced by high-frequency

oscillations. D'Arsonval showed, however, that intense high-frequency currents passed through the tissues may

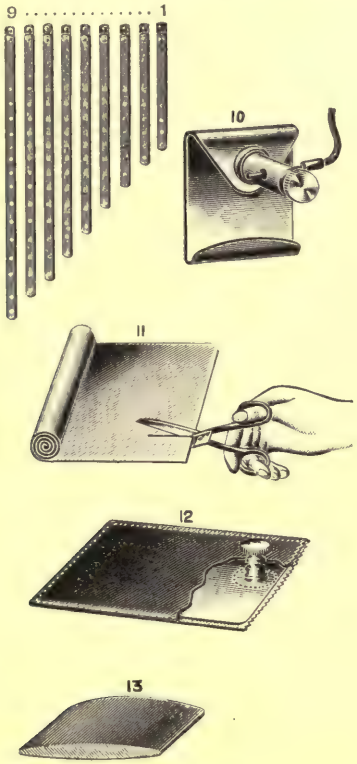


FIG. 200.

1 to 9, "Limpet" aseptic rubber belts. 10, "Limpet" terminal attachment for slipping beneath belt after electrode has been fixed in position. 11, Cutting electrodes of any desired shape from non-oxidizable plastic electrode metal. 12, Old type electrode with fixed terminal; the dotted line shows the position where a fracture invariably occurs after a short time in use. The electrode is fitted in a non-aseptic absorbent case. Entirely superseded by "Limpet" system. 13, Showing section of "Limpet" aseptic rubber belts; the wedge-shaped edges render the belt more comfortable to the patient.

raise their temperature very considerably. This observer, indeed, produced such heat in experimenting on animals as to cook the tissues in certain portions of the body in a

few minutes. By the use of the apparatus described under High-Frequency we can produce either these or diathermy currents by a simple adjustment. We reduce the voltage to about 20,000, and raise the amperage by the same adjustment to from $\frac{1}{2}$ to 3 amperes.

The current is much the same as high-frequency, but the oscillations very much condensed, the time between them being very much shorter. We use what is known as damped oscillations, avoiding long intervals between the oscillations, such as we use in high-frequency currents.

If the apparatus be properly regulated, the length of each group of oscillations is equal to the length of the pause, and under these conditions the best results are obtained.

Alternatively to the spark gap and 12-inch coil we may use the special diathermy apparatus, the spark gap of which is really very similar to the Telefunken spark gap used in wireless telegraphy.

There is a frame containing two pairs of electrodes, each with a silver disk in the centre, kept apart by two mica rings. It is between these silver disks that the discharge takes place. A small resistance coil is connected in parallel with one of the pairs of copper electrodes, so reducing the discharge voltage and increasing the rate of sparking.

To prevent the electrodes from getting overheated, large copper disks are fitted to the centre and end of each pair which act as radiators.

Two strong glass plates are used to insulate these from electrodes from the case, which is placed over the whole of the spark gap, since it is not safe to risk touching it on account of the high-tension low periodicity A.C. current at the terminals.

The current, which is an alternating one, is turned off and on by switch *S*, and passing through *R*, the resistance (subject to regulation), it flows to step-up transformer *T*, where the voltage is multiplied by 10 with an output of 2 kilowatts. The condenser *K* becomes charged, and discharges itself automatically through the spark gap *F*. This is of the silent type, the sound being almost nil. The number of oscillations is about a million a second. The high-frequency currents thus generated in the oscillating

current are carried to a movable coupling coil M^1, made up of several windings. This coil is manipulated by a lever H, which brings it into relation with another coil, M^2—a fixed one, in which a current is generated varying in intensity with the distance between the two coils: in a

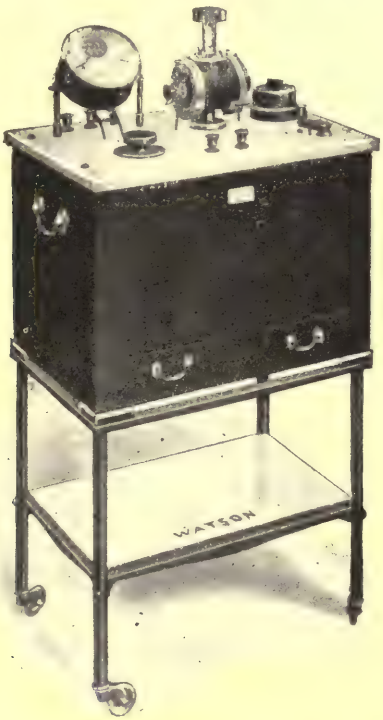


Fig. 201.—The Diathermy Apparatus.

word, in inverse ratio to the distance between them as estimated by a hot-wire meter. This is called the magnetic coupling.

Coil M^2 is subdivided into 0, 1, and 2 sections, terminals from which are connected with the patient. If there is much resistance, as in the whole body, 0 and 2, the electrodes being held by the patient's hands, and if there is little resistance, as where it is a question of treating a single joint, then 0 and 1 are used. The maximum current strength is $2\frac{1}{2}$ amperes, but this is seldom requisite or

desirable. Any faradic effect is avoided by means of the special spark gap carefully adjusted. It must be prevented at all times.

A very easy and practical method of testing diathermy currents, if in a plate or saucer of egg or meat albumen, when very soon will be seen from the process of coagulation in what direction the current is flowing, and in some degree with what intensity.

Fulgurating currents of high amperage are only used in surgery, and with them we have nothing to do. Medical currents of lower amperage are used where no destruction of tissue is needed or desired. The heat produced is

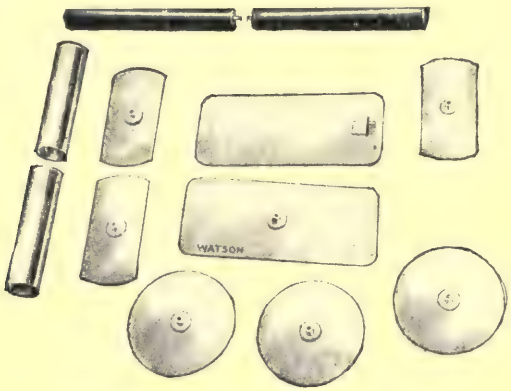


Fig. 202.—Diathermy Electrodes.

developed in the depths of the tissues, as above stated, while the patient only feels it on the skin surface.

The sensation of heat persists a considerable time after the treatment ceases. As regards temperatures borne at about 112° F. (45° C.) the sensation becomes painful, and cannot be tolerated any higher. An active hyperæmia is induced, which in certain conditions cannot but be beneficial.

The therapeutic effects are at once decongestive and analgesic. Pain is materially relieved in such conditions as sciatica and neuritis elsewhere, the various arthrites, and even in neuralgia.

Method of Application.—The type and manner of using the electrodes calls for special care and consideration.

There is no difficulty in inflicting severe burns if care be not exercised at all times. Lewis Jones recommended bare metal electrodes of pure tin well adapted to the part, and applied well moistened with strong saline solution. The trouble with these is uniform adaptation to surfaces which are frequently irregular.

Sharp sparking occurs from points not actually in contact with the skin, with the most unpleasant effects on the patient. The difficulty, moreover, is that the personal factor both as regards attendant and patient vary greatly. If the medical man is not carrying out the treatment himself, the attendant may be careless and the patient long-suffering, thinking the sparking a part of the treatment, and tolerating to the limit of endurance, with a resultant burn.

Perfect coaptation must be secured by elastic bands of webbed bandages, and the surface of the electrode fits better when covered with a well-moistened pad of felt or several layers of lint or gamgee. There is much to be said in favour of a layer of clay or radioactive earth between the electrode and the skin. Nothing can be better moulded to the part, and its humidity always insures good conduction in the skin.

The Static Machine.

This is one of the very earliest methods of employing electricity, both Benjamin Franklin and John Wesley having interested themselves in it. It differs from galvanism in that there is no chemical action, but the current is entirely generated by friction and induction. In an elementary type of machine a positive charge is produced by friction on a revolving plate of glass. This is carried to collecting combs near one of the poles of the machine, and induces a negative charge in the comb and a positive charge in the pole. The negative charge escapes from the combs of the machine as a static breeze or brush discharge, which, passing to the surface of the plate, neutralizes the positive charge there, and leaves the plate ready to be recharged by friction at another part of its revolution. The rubber is negatively charged and connected with the other pole of the machine.

The Wimshurst is perhaps the best-known type of glass static machine, and the Toepler and the Holtz are in vogue in the States. The trouble with all glass machines is, however, the difficulty in starting, owing to moisture collecting on the plates. It is customary to enclose the plates in a glass case, and keep the air dry by means of a free supply of chloride of calcium, but even so we know few people in this country who have not discarded a glass machine and taken to those constructed of vulcanite.

Vulcanite plates are said to buckle, but the writer has had a ten-plate in steady use for over eleven years, and this has never happened, and on most days the machine can be started very quickly, always being kept in a dry, warm room with windows closed, except in summer, and a good fire going in winter. Machines of this type are made by Gaiffe, Dean, Watson, and others. Gaiffe makes the plates 22 inches in diameter of a specially prepared vulcanite. They are run at a speed of 9,000 revolutions per minute, and as each alternate plate goes in a different direction the relative speed is of 1,800 revolutions. The machine may be ten, twelve, or twenty plates; the main axle is driven by a leather belt running on the pulley worked by a $\frac{1}{4}$ horse-power motor. The axle does not pass through the centre of the plates, but on the side away from the motor and below the plates. From it small driving bands with a twist on them pass round the axle of the plates, driving each a different way. Tinsel brushes collect the current on to the combs, and thence it passes to the poles. We have not used Leyden jars with this machine, as is quite customary. There has been very little difficulty in starting; this is usually done by getting the motor going and gradually increasing the speed, while with the fingers of each hand we keep up friction on two plates, the plates which have the best effect varying with the individual machine. The fingers should be dusted with gold size, which makes the process easier. One great point is to keep the plates clean and always covered with a sheet or waterproof cloth when not in use. Periodically they should be rubbed up with methylated spirits.

The base of the machine is of substantially made cast-iron frame fixed on to a heavy table or drawer stand, and placed preferably away from the wall.

An insulated platform is needed for use along with the machine, size 2 by 3 feet, with glass legs about 9 inches

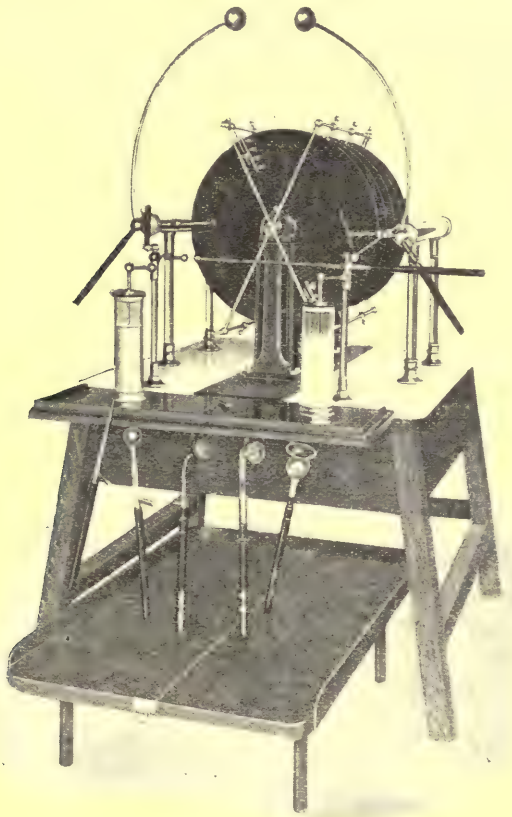


Fig. 203.—Static Machine with Six Vulcanite Plates.

high, kept free from dust and moisture. The platform should not be in contact with any other object, nor near enough to lose any of the electric charge by convection or brush discharge to a neighbouring object.

The platform is connected to the machine, as a rule, by the shepherd's crook, a brass rod about 5 feet long. This

is hooked over the prime conductor with the other end resting on the platform. A square piece of metal about $\frac{1}{8}$ inch thick usually lies on the top of the platform, and the crook is allowed to come into contact with this. A stool is placed on the platform, preferably slotted in with the back legs at least, to prevent the patient from slipping off backwards and having a nasty fall.

Over the patient's head is suspended the crown, either a ring of brass with points or a cup-shaped piece of metal with serrated edges. This is hung to a lofty arm from a stand on castors, which is connected by a chain to the pole, not connected with the platform, or in some cases merely earthed.

If Leyden jars are used, they stand on the table which forms the base of the machine, and when in use are connected with the poles of the machine. They have largely fallen into desuetude, however, and if they are not very carefully handled the patient may receive a pretty severe shock, at times receiving the whole discharge from the two jars. A concentrator is sometimes employed, and consists in a brass rod mounted on a metal tripod, and so arranged that its pointed extremity may be directed towards any part of the patient. A chain leads to it from one pole of the machine or from the ground. The voltage of the machine is estimated by noting the length of the spark which passes from the discharging rods, while the machine is not connected with any other object. The distance across which a spark will flash is the measure of the electric potential. A spark 8 mm. long between two highly polished balls of, say, 3 c.c. diameter represents something like 20,000 volts (Tousey).

Positive and Negative Poles.—The poles are distinguishable by the character of the discharge. It is noticeable that when the discharging rods are sufficiently separated to give a silent discharge there is a bluish colour at the negative pole, especially if the room be darkened. This consists of particles of electrified air radiating in lines from the negative pole.

Bright thick trunks are discerned radiating from the positive pole, known as Greville's trees. They are straight

for perhaps ½ inch, and then split into crooked branches, which again separate into twigs radiating towards the negative pole.

If the poles are brought together, the discharge becomes sharp and crackling. An irregular bright line, like lightning in a picture or photo, comes from the negative pole. At a short distance from the negative pole this line becomes very bright for perhaps ½ inch. If we bring a pointed electrode (earthed) towards the negative pole, we see fine blue lines discharging; whilst if the same be done with the positive, we see a point of light on the electrode, which disappears when the proximity is so great as to cause a discharge.

We have described above how the patient on the stool is connected with the machine by a crook. There is some difference of opinion as to which pole the crook should be attached to. Lewis Jones held that there was less risk of sparking the patient if it is hung over the positive pole and the negative pole is earthed. If the opposite is done, sparking from the positive readily occurs, and may hurt, or at any rate alarm, the patient. The negative electric breeze is always weaker and less alarming to a nervous patient.

There are numerous ways of using the static machine:

Simple Charging.—In this no crown or brush is used. The crook connected with the positive pole rests on the insulated stool on which the patient is seated, the effect being enhanced if a metal sheet is placed under the legs of the stool and the patient rests his feet on it. The patient merely feels a slight breeze, and the sensation as a whole is agreeable.

This may last for fifteen or twenty minutes, and may be elaborated by putting the crown or wooden disk with spike over the patient connected with the negative pole. This is what is called the "static breeze." If the shepherd's crook is connected with the negative pole and the other end lying on the stool, while the positive pole is earthed and the disk suspended from a stand uninsulated, the patient will be getting a positive breeze—*mutatis mutandis*, he will get a negative. The breeze, of course, comes from the disk

or corona. Alternatively the corona may be connected with the positive pole by a chain, the earth connection broken, and the top of the stand made of a glass rod, so as to complete the insulation. This makes a stronger breeze Instead of being applied to the head, or along with it, a breeze may be applied all down the patient's back by a specially made brush or toothed electrode, like a rake. This is very pleasant and bracing, and helpful to neurasthenics with "weak backs" and vague neuralgic pains along the posterior spinal roots.

This is a convective brush discharge. Another way of doing it, requiring, however, the time of the attendant, is by means of a fibre brush or wire toothed disk *insulated* from the person manipulating it. Instead of a brush, in very local affections a mere point may be used. Good results are obtained in neuralgia and nervous headaches.

If metal or wire points are used, we call it the *spray* discharge.

Sparking or disruptive discharge is arranged in much the same way, but a metal ball electrode used in place of the point or brush. The effect is much sharper and more painful, and requires care in handling. The larger the ball, the sharper the spark; the strength is also dependent on the rate of the revolutions of the plates, but a handy way of "watering down" the charge is for the operator to place his boot on the platform so as to divide the charge with the patient.

In order to localize the discharge for some specially painful point, a metal disk may be secured on the part with strapping or a piece of tape threaded through slots in the side. Bony points must be avoided, or the pain may be severe.

Alternatively Tripier's electrode may be used—a semicircle of glass rod with a sliding adjustment, so that the distance between two balls may be regulated to a nicety. The electrode is then kept into contact with the part treated by means of a leather-covered electrode. A roller electrode is sometimes used, sparks passing from the whole length of the roller, provided it is not in contact with the skin. The roller may be simply run over the surface of the patient's

clothes, and the thicker they are, the greater the stimulation. Here, again, the operator should hold the earthed electrode by an insulated handle and dilute the charge with his foot on the insulated stool.

Static Wave Currents.—This is a variety from simple charging. The patient is connected up in the same way, but the negative conductor earthed. The two prime conductors of the machine are then brought close together, so that a stream of sparks passes between them. Positive conductor and patient are both rapidly charged. If the conductors are separated, the strength of the current is increased.

An important point arises in connection with earthing one prime conductor as well as the electrodes in use through the operator's feet, as is often done. Most machines are more powerful in their discharge when one set of conductors is earthed—as they are connected with an inexhaustible supply of electricity—in the earth. A second point is that the person handling the electrode, as in the convective discharge, is protected against shocks, for he is at the same electrical pressure as the electrodes he is handling—the zero point of earth pressure.

Ionization.

Ionization, or cataphoresis, or iontophoresis, as it is sometimes called, is a method of utilizing the power which electric currents possess for setting the various constituents of a saline solution in orderly motion in a definite direction. For all practical purposes the human body may be regarded as a saline solution, and obeying the same laws as regards conductivity.

Ionic medication is the introduction of various drugs into the superficial structures of the body through the skin and underlying tissues, and setting up electro-chemical interchange in the deeper structures such as joints and nerves.

Distilled water is a very bad conductor of electricity, rain water a better conductor, but if an acid or salt be

added the conductivity is very materially increased, and the solution is then called an electrolyte.

Practically all soluble chemical substances undergo a change in their constitution when the electrical current passes, and their constituents migrate according to certain fixed laws which we shall give below in detail. In the commercial process of electroplating, for instance, the silver atom Ag migrates to the kathode to which the article to be plated is attached, while the acid moves towards the positive pole. Such movements are based on the elementary principle that like repels like, and *vice versa*.

An ion is an electrically charged chemical atom. The Swedish chemist Arrhenius held that the action of water on an electrolyte was one of dissociation, the molecules of the salt being split up by the solvent, and this is probably true if the solution be diluted to infinity.

The electrolytes spoken of above which conduct the electricity contain a number of neutral molecules, free positive and free negative ions. When the electric current is passed a disturbance occurs in the solution; numerous positively charged and negatively charged ions are gathered around the positive pole (anode), and also the kathode.

The moment the current begins to flow, the positive ions in the region of the anode and the negatively charged ions near the kathode follow the universal electrical law that like repels like, and *vice versa*. The negative ions travel away to the anode and the positive ions to the kathode. The speed with which this adjustment takes place will vary with the concentration of the solution and the proportion of basis radicles to the acid or hydroxyl radicles.

A simple experiment will help to make clear the process and convince the observer that penetration of tissues in the human body does take place. Take a piece of steak and plunge a copper wire into it which is connected with the positive pole. A little way from the copper wire plunge a platinum wire into the steak connected with the negative pole. Now pass a current of, say, 20 milliamperes, and a streak of green oxychloride of copper will be found starting away from the copper electrode and diffusing through the beef to the negative electrode.

The beginner is sometimes rather confused by the fact that ions move with no regard to the flow of the current—they often move against it, indeed. As is well known, the current usually passes in the external circuit from the positive pole to the negative. But when passing through an electrolyte the acid radicles are set free around the positive pole, travelling in the opposite direction to the current, while the basis metallic radicles are set free around the negative pole and repelled by the positive pole, and travel in the same direction as the current. Ions passing towards the negative pole, being positively charged, are called kations, and those which travel towards the positive pole are negatively charged and called anions.

Metallic and basic radicles, being themselves positively charged, should be connected with the positive pole when it is desired to introduce them into the human body—the most common solutions being cocaine hydrochlorate, sulphates of magnesium, zinc quinine, etc. Here the metallic ions penetrate the tissues and the sulphates remain around the positive pole.

Acid radicles are negatively charged, and should be introduced by the negative pole, as they travel towards the positive. Such are potassium iodide, chloride of sodium, salicylate of soda. The acid radicles penetrate the tissues, and the metallic radicles remain around the negative pole.

A rule may thus be formulated for procedure which it is very important and not always found easy to bear in mind: *The ion we desire to introduce into the tissues must be connected to the pole having the same electric charge as itself.* For instance, in treating a sciatica with a pad on the patient's thigh or buttock, we must remember to have the pad soaked in, say, 2 per cent. of iodide of potash connected with the *negative* pole, while the foot is placed in a basin of water in which lies the positive pole.

In treating warts on the hand with magnesium sulphate, we connect the pad over the wart with the positive pole, while the negative pole is connected with a pad or armlet round the wrist.

The strength of the solutions employed varies from

1 to 3 per cent., but should not be stronger, as otherwise the treatment becomes painful.

Stock solutions should be kept of 4 per cent., which can be diluted if desired. Soloids are prepared which make a solution of 1 per cent. when dissolved in an ounce of water. The desirability of using pure—preferably distilled—water for the solvent becomes obvious when we remember how delicate the solution is we are dealing with. In practice there is no objection to wetting the inactive pole with normal saline solution, as the current is the more easily carried.

A further rule to remember is that *the effect of the ionization depends on the speed of penetration of the tissues, which varies directly with the milliamperage passing.*

As we have said previously, the charge in metals and alkaloids is a positive and in non-metals a negative one. Let us assume that we are dealing with a solution of chloride of sodium, or common salt, and the electrodes are adjusted and current passed. The halogen elements carry a negative charge and move against the current, while the metal is positive and moves with it. The condition before the current passes may be figured as below:

Cl	Cl	Cl	Cl	Cl	Cl
Na	Na	Na	Na	Na	Na

After the current has passed it is—

				Cl	Cl	Cl	Cl	Cl	Cl
Na	Na	Na	Na	Na	Na				

The sodium ions here move with the current and have accumulated at the negative pole, while the chlorine has moved against it and accumulated at the positive pole. If we are using iodide of potash on a rheumatic knee or elbow, the following would take place:

	Anode.		Body.			Kathode.		
+	K	K	Na	Na	Na	K	K	−
	I	I	Cl	Cl	Cl	I	I	

Before the current is turned on:

+			K	K	Na	Na	Na	K	K	−
	I	I	Cl	Cl	Cl	Cl	Cl			

The ions gradually replace the normal constituents of the part.

Supposing we are going to introduce zinc salts by cataphoresis, we apply a moist pad impregnated with the salt to the skin, and superimpose on it the electrode leading from the positive pole of the switchboard or the battery, whichever we are using. The electrode should be of zinc. As the current flows the zinc ions, constantly renewed, pass down to the deeper tissues. The similarity of the base metal is important to avoid contamination. If quinine or salicylic acid be used, the lint or cotton-wool should be kept well moistened with the solution, or, better, the administration should be conducted with a glass reservoir electrode covered with a membranous diaphragm. If this be not used, then the electrode should be of carbon or platinum. Generally speaking, the switchboard, when connected with the main, is greatly to be preferred to the use of a battery of, say, 24 cells, as with the former we gradually increase the current by cutting out resistance in a rheostat, while with the battery we have to be constantly putting on fresh cells, and the change from one stud to another is quickly noticed by the patient, to whom it causes considerable pain and discomfort if the current be fairly strong.

Care taken with details of the procedure well repays the operator. Conducting cords should be of copper flex, so as to avoid a bad contact. This would, of course, cause the patient discomfort due to minor shocks. The very slight silk-covered cords supplied with cheap batteries are to be avoided for this reason.

As regards *electrodes,* these need not be large in size, and are best made of sheet metal. The chain-mail type are not to be recommended. If adequate care be taken in adjusting the material lying between the electrode and skin, an electrode with a diameter of 2 inches will give an even diffusion of current over an area measuring 5 inches each way. Few cases will require more than this. Aluminium is a very suitable metal to employ. The binding-screw should be fastened to it, and preferably at one side rather than in the centre of the upper surface. Small holes in the

periphery are convenient for stitching felt or other fabric to the plates. The felt insures a good diffusion of current and takes up the products of secondary reactions occurring at the surface of the metal. Before using, the felt should be soaked for a long time in hot water with some soda or ammonia in it, in order to remove the natural oily matter which is invariably present when the fabric is new. Below

FIG. 204.—HANDLE WITH COPPER ELECTRODE.

the felt is placed the electrolytic layer proper, which is of lint or gamgee tissue, four, eight, or even sixteen layers thick. While the felt is always cut larger than the metal, the cotton layer should be cut larger still. This latter will act as a reservoir of the electrolyte, from which the ions pass into the skin once the current is switched on. If the electrode is of the same metal as the base of the salt used, such as zinc or copper and zinc sulphate and copper sulphate,

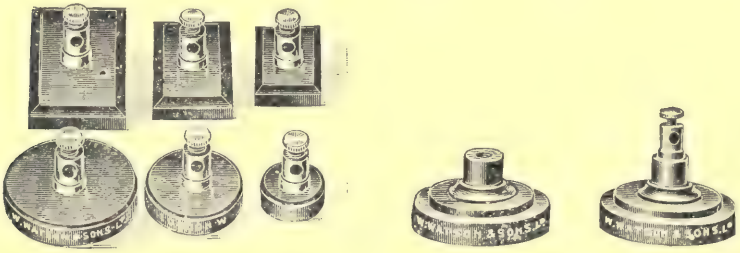


FIG. 205.—COPPER AND ZINC ELECTRODES.

little in the way of a reservoir is needed, as the metal is so constantly renewed from the electrode. Few layers of fabric are then employed. Lint is quite suitable for small joints, such as those of the fingers or toes, but for a knee or elbow gamgee is best.

Where practicable, it is desirable to have the electrodes of the same metal as the base of the salt used; but if we are using KI or sodium salicylate, then it is highly desirable

to use several layers of lint or gamgee, to prevent the ions of the metal electrode reaching the skin.

In treating large areas and conditions such as sciatica and rheumatic trouble, big currents of 100 or more milliamperes may be called for. It is essential in such cases to use large electrodes of flexible material easily appliable to the parts. A heavy current with a small electrode will easily produce a blister or painful burn difficult to heal. The most flexible electrode we can get is, of course, water, and there is therefore a great deal to be said for using the pots of a Schnee bath in electrolysis, as has been our practice for a number of years. The only irritation the patient suffers here is usually at the water-line, and this may be largely prevented by putting a layer of liquid paraffin over the surface of the water, though, of course, this adds to the expense of the treatment. On the other hand, with large areas a very considerable amount of gamgee tissue and lint may be consumed at each treatment if we do not use the Schnee cells. By this method currents of considerable intensity will be evenly distributed over the part, as the whole of the solution contained constitutes the electrode.

It is hardly necessary to emphasize the necessity in such cases to be unusually careful with all connections, as should an electric cord conductor get a rift suddenly, the shock to the patient may be both very painful and damaging. The connecting wire should preferably be soldered to the electrode, and such electrodes, when used for lying or sitting on, of course, have the obvious advantage that the patient is not sitting on a projecting screw, nut, or stud.

Preparation of the skin is important before ionization; it should be washed with soap and water, and ether or alcohol wiped over it before beginning to remove all grease. Acne spots, etc., must be carefully covered with wool and collodion. The removal of rings, etc., is essential, and must be invariably carried out. One of us recalls a very painful burn inflicted through neglect of this by a careless attendant. Burns so inflicted are very slow to heal.

The sensations of the patient if the treatment be properly given are slight. The current is gradually turned on, several minutes being taken to reach a maximum. The same

procedure is adopted in finishing, the current being gradually reduced.

Unequal density of current causes pain, and a blister may form. The galvanometer must be carefully observed, and if the current registered suddenly rises without any adjustment by the administrator it may be due to a breaking down of the skin resistance, and cause a burn if the current be not reduced.

Half an hour is usually long enough for a séance, unless in special cases.

Success will vary with the care of the administration and the size of the electrodes, as large sizes as possible being always used.

Zinc Ionization.—This is used for the treatment of rodent ulcer, the zinc sulphate salt being employed. A pad of lint containing 1 per cent. solution is placed over the area of the ulcer. A zinc electrode, also padded with lint soaked in the solution, is connected with the positive pole and applied over the area affected.

The indifferent electrode is applied at some convenient spot. If the ulcer be on the surface of the face, the indifferent electrode is applied at the back of the neck.

The strength of the current will vary with the size of the electrode, allowing 2 milliamperes for each square centimetre of the electrode. This is applied for from ten to fifteen minutes. Most patients can bear this current quite well, but in most cases it is desirable to use a little cocaine, introduced also by cataphoresis. Lint is dipped into 1 per cent. cocaine solution and the current passed for a few minutes, the same electrode being used as for the zinc ionization. The penetration of the zinc ions gives the rodent ulcer a milky-white appearance on the surface, which fades gradually.

Copper Ionization is used for ringworm, the best salt being copper sulphate, 1 per cent. solution. A pure copper electrode is used with the positive pole. It is also used in lupus erythematosus and in rodent ulcer.

Cocaine is used as described above, and is of service in some varieties of neuralgia. It is probably the safest way of using cocaine to prevent a habit; the patient need not

know what is being used, and the paraphernalia employed will put the idea of personal use out of his head any way.

Lithium is used for gout, rheumatoid, and synovitis of rheumatic origin. A good combination is lithium on the positive pole and iodine on the negative.

Magnesium.—Multiple warts on the hands can be easily removed by the use of magnesium ions. These are obtained from a 1 per cent. solution of magnesium sulphate, using a carbon electrode with a pad of lint to hold the solution. A magnesium metal electrode is advantageous.

Salicylic Acid.—These ions are useful in treating rheumatism, sciatica, and neuritis. A large pad with 1 per cent. is used attached to the negative pole on a carbon electrode. If used for arm or knee, the hand or foot is placed in a porcelain bath fitted with the positive electrode for convenience.

Sodium Chloride.—Chlorine ions promote the absorption of newly formed fibrous tissue, and have given good results in cicatricial contractions. Potassium iodide is used for iodine ions, with or without iodine painted over the part treated, and gives good results in chronic rheumatic cases. Quinine has been used (with the positive pole) with success in neuralgia.

The Bergonié Treatment.

The underlying principle in this treatment is the electrical stimulation of the body muscles to a therapeutic end, simulating exercise.

It is a well-known fact that the proper use of any muscle or organ increases the vitality peculiar to that muscle or organ, at the same time favourably influencing the vitality of the whole body.

This has been specially demonstrated as regards the muscular system, which is known to be developed best by graduated general exercises (see section on Physical Training), which at the same time prevents defective combustion of the metabolic products. By means of the Bergonié apparatus the muscles are caused to contract some hundreds of times per minute, and to do so without giving rise to any undue fatigue.

The special coil employed in this machine is of a coarse faradic type, with a break of special construction, as shown in Fig. 206. The special points about the break are that it emits a purely musical note, without variation of pitch or intermittency; the interruptions are about 50 per second, and there must be no sparking between the screw and the trembler, or the treatment will be painful and cause discomfort to the patient. The correct and incorrect wave tracings are shown below, taken with a Blondel oscillometer. Fig. 206 shows the correct form of undulation, while Fig. 207 shows the undulations of a badly adjusted interrupter.

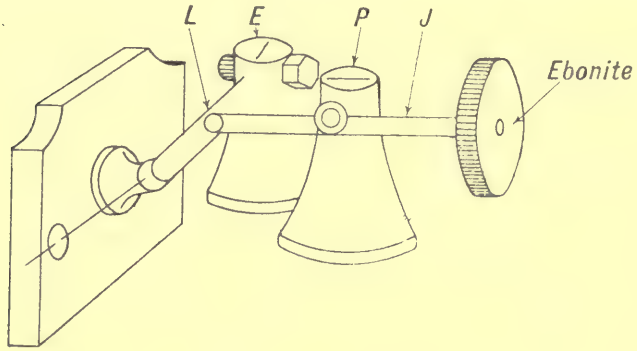


Fig. 206.

The former, being irregular, causes pain which is quite insupportable.

The **Coil** and the break are mounted on a solid marble base containing a large condenser, which is connected across the point of the interrupter—that is, in contact with the platinum contact pillar and the pillar supporting the contact spring. It may be either worked from accumulators or the direct-current supply main, and requires roughly 60 watts—*i.e.*, 2·5 amperes at 24 volts. The intensity of the current in the secondary is roughly 500 milliamperes.

The Metronome (Rhythmic Reverser).—Being provided with a suitable faradic current, we have to pass it through a metronome or rhythmic reverser introduced by Bergonié. By means of it we are able to avoid fatigue and exhaustion of the muscles. It gives the necessary alternations of

excitement and repose in the muscle fibres, just as it regulates the cadence of music. At every heart-beat the current is reversed, which makes the muscular stimulation painless and pleasant. The oscillograph shows the undulations of the faradic current to be asymmetrical. The excitation of

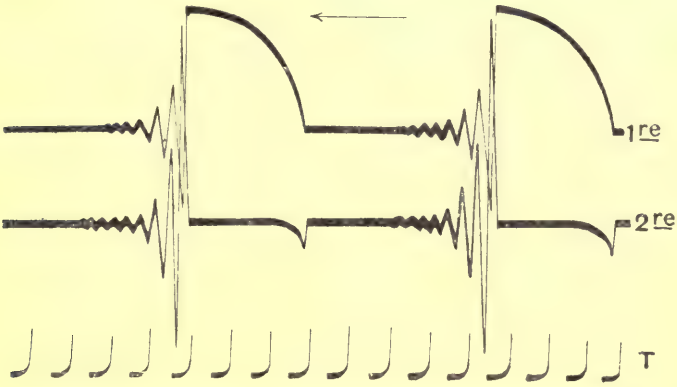


FIG. 207.—OSCILLOGRAM OF THE CORRECT WAVE FORM.

a muscle is quite different, according as we use one or the other electrode. In order to obtain a painless and pleasant contraction it is necessary at each break to reverse the poles when the asymmetry disappears. It has been found that regulating the metronome to one double beat per

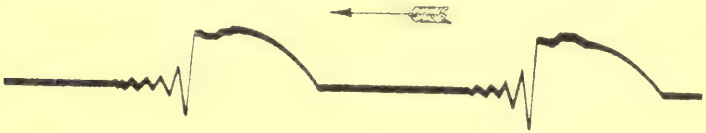


FIG. 208.—INCORRECT FORM OF UNDULATIONS FROM AN UNSUITABLE OR BADLY ADJUSTED INTERRUPTER, TAKEN WITH BLONDEL'S OSCILLOMETER.

second gives the best results. By adjusting the mercury this may be divided into four equal periods. During the first quarter of a second the muscle is in repose; during the next it contracts from the stimulation of one pole; during the third quarter of a second it is again at rest,

and during the final half a second it again contracts from the stimulation of the opposite pole. There are thus two intervals of repose with two intervals of excitation; the stimulations are of unequal intensity, though of equal duration, the sequence being—repose, strong contraction; repose, weak contraction. There is therefore a distinct resemblance to the variations of mechanical energy in a gymnastic exercise.

If pain, fatigue, and exhaustion of the muscle are to be avoided, it is necessary to avoid producing the condition known as tetanus. Each electrically executed contraction must be followed by a rest of equal duration, and if proper rhythm be maintained this is just what happens. The metronome, by rhythmically inverting the current, enables one to attain almost perfect regularity and to avoid muscle fatigue and pain. A patient usually finds two contractions per second of the muscle or 120 per minute very comfortable, and if this be kept up for forty minutes to an hour it is hardly necessary to say that there is a great output of muscular energy and tissue combustion going on.

The switchboard of this apparatus is extensive in area and looks rather complicated—more so than it really is when we come to examine and use it. There are two points of entry for the current, and a hot-wire meter graduated from zero to 100 milliamperes; it is also usual to have an automatic clock, by means of which the duration of the treatment may be regulated automatically. There is a general rheostat controlling the entire current to the patient, with three rows of resistance—one with 100 ohms, one with 1,000 ohms, and one with 10,000 ohms. The polarity of the electrodes is controlled by twelve knife switches. If the switch is turned up, the current is positive; if turned down, negative. In addition to the general rheostat, there are twelve minor rheostats in series with each circuit and controlling the current therein, thus regulating the amount of current in arm, leg, back, abdomen, etc. These are simply sliding resistances with 20 stops in each, each stop being equal to 100 ohms. The terminals for each circuit are grouped into a special junction-box, from which a twelve-way cable leaves and terminates in twelve-way

plugs, which is inserted into a corresponding socket attached to the special chair figured and described below.

Method of Application.—The patient wears some clothing which permits of free access to the body surface, which can be easily slipped off if need be, such as a sheet with arm-

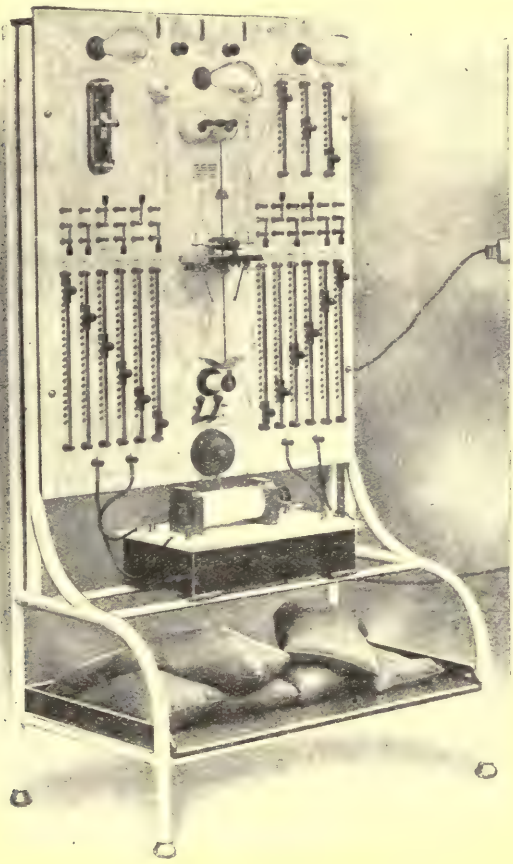


FIG. 209.—BERGONIÉ SWITCHBOARD.

holes or a light dressing-gown reversed, with the buttons at the back. This permits of contact with the back and seat of the patient. The patient reclines comfortably in the chair, and four more pads are placed on the surface of the body, two on the abdomen and one on each thigh. The

electrodes are then adapted to these. They are kept in apposition by the use of sandbags filled not too full, so that they can readily adapt themselves to the surfaces of the body.

As regards the patient's sensations, he feels at first something like a surge of blood in the parts treated, then pulsations begin and the muscles contract, raising the sandbags rhythmically in time with the metronome.

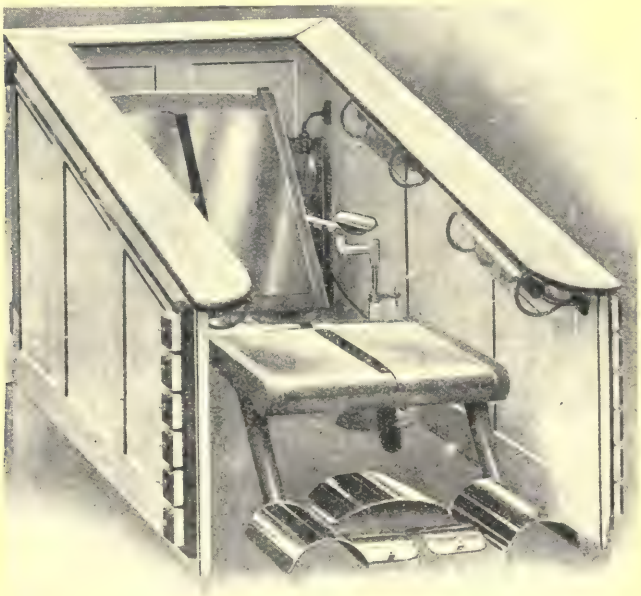


FIG. 210. BERGONIÉ CHAIR.

The general rheostat should be cut out bit by bit, and the various circuit rheostats so adjusted that the current in each circuit is such as to produce equal contraction in the various muscles; after that the general rheostat can be further cut out to suit the patient, when all the muscles will be seen to contract rhythmically along with the metronome without any painful sensation to the patient.

Electrodes.—The aim of the treatment being to excite as many muscles as possible, we have to make use of both a considerable number of electrodes and of those with large

surface area. The patient somewhat resembles the knight of old, being enveloped in metal. The electrodes are of two types, fixed and movable. The fixed electrodes form the back and seat of the chair, which are covered by four separate plates or sheets of brass or aluminium—one for each buttock and one for each side of the back. They may be used bare, having previously been warmed up in cold weather, or, better, should be overlaid with towels wrung out of hot water. The movable electrodes of the same material are semicylindrical in pattern. They are placed on the thighs, the calves of the legs, the abdomen and forearms. Thus no less than twelve electrodes are used, having a joint surface of 10,000 square centimetres.

Excepting the abdominal electrode, they are all symmetrical in pairs; the polarity of the current in any region may thus be very readily changed. The electric resistances of the patients vary, and may be as low as 200 ohms.

For fixing the electrodes rubber bands have been used, but quickly waste, and the most effectual way is to employ sandbags. They not only maintain good contact, but increase the work done by the violent rhythmic contractions of the muscles.

Weights up to 2 hundredweight have been used with good results, as during faradization it is lifted without fatigue or sensation of discomfort. Patients often, indeed, prefer heavier weights, as the contact is more perfect.

Duration and Frequency of the Séances.—The time should be gradually increased—from twenty minutes for the first time will be usually enough, then quickly increased to half an hour, then up to an hour, and if necessary this may be given twice a day.

If possible, the patient should be looking out of a window, with a view of some objects of interest to distract his or her attention, or have someone sitting by who can talk amusingly and prevent boredom. Otherwise the treatment is a little trying from its duration. The present type of apparatus is quite silent, and the rather irritating tick-tock of the metronome done away with.

This treatment has been evolved from various attempts to apply faradism or interrupted galvanism to large areas

of the body surface at once, and its use is mainly for those patients whose disorders would yield to the faradic current when applied in definite ways and under definite conditions. But it was not until this apparatus was introduced that such treatments became at all possible; for despite the fact that attempts had been made to reduce the body-weight by means of electricity, the process had been so tedious and accompanied by such discomfort that it had to be given up.

Now, however, we have an ideal circulatory stimulant, and one that is unaccompanied by any serious disadvantage. The worst that can be said about it is the duration of the treatment, both per séance and for the course. Considerable time elapses in cases before very material improvement is noticeable sometimes. In most cases a drop in weight is noted from the start, however.

Few people know how to exercise their muscles properly, so that they remain largely unused and partly degenerate, and become a sort of backwater for morbid waste products of deficient metabolism. It is here that the Bergonié system does most good. Muscular pains and stiffness may yield to two or three treatments.

In undergoing obesity treatment a patient may lift seventy times a minute 1 hundredweight or more of weight, and rise as fresh as from a good sleep. Thus great advantages are held out to those patients whose increasing corpulency makes their life burdensome, as well as to those of the bilious lymphatic type, whose muscles are firmed up and metabolism stimulated by rhythmic faradism.

Medical Uses.—Various conditions other than mere obesity are benefited by this treatment. The suitable disorders may be grouped under three heads: (1) Metabolic disorders; (2) vasomotor disturbances; and (3) atonies and paralyses.

Metabolic Disorders.—In gout the main purpose is to promote elimination. Reduction of superfluous flesh may be needed at the same time, as many gouty patients are stout and lethargic. If there be high blood-pressure, this is also reduced by the treatment.

The suggestion has been made of using the apparatus in

cases of chronic nephritis, but this is open to some objections. The idea underlying it is that the "chair" acts as an accessory heart, and so promotes elimination here also.

Vasomotor Disorders.—In arterio-sclerosis the treatment assists the cardio-vascular system, takes the strain off the heart, and aids elimination. Short periods of treatment suffice, such as twenty minutes to half an hour with a light current.

In atonic conditions and paresis of limbs, stomach, or intestine, good results are achieved. For the latter the stomach electrodes are, of course, the most important, and good contact should be insured by the free use of sandbags.

It has been suggested that the chair may be used in the place of exercise for those who are actually paralyzed or bedridden and unable to walk.

In cardiac conditions with failure of compensation relief is certainly afforded, the faltering circulation being assisted. The rhythmical contractions increase the *vis a tergo* and lessen the tendency to anasarca. Short sittings and light weights only are used.

Obesity.—Cases of moderate stoutness we can only regard as exaggerations of the normal structure of the body. After middle life, and sometimes before, especially in the female sex, we see cases of mild obesity only amounting to what is called "full habit of body," due to overeating or deficient exercise, or both combined. Excess of fat also makes walking more difficult, while, on the other hand, much exercise may improve the appetite and so tend indirectly to the accumulation of fat.

The Bergonié system exercises the muscles and stimulates the circulaton without fatigue or strain on the nervous system. A certain amount of work is done by the muscles, and this is partly regulated by the weight of sandbags employed; the heart is helped in its work by the promotion of venous return. The effect of this treatment in such cases is very striking, and the most gratifying results are often obtained. Apart from the diminution of the body-weight, the stimulation of the lymphatic and vascular system is most important. There is a stirring up of latent masses of

flesh with their dormant excretory products, as Dr. Conn well puts it.

In the technique of treatment the most important point is to emphasize the obtaining of maximum contractions, and to use the maximum number of sandbags which the patient can do with. The muscular system is thus exercised *bon gré, mal gré*, quite out of proportion to the work it would do in ordinary pursuits of daily life.

Sometimes it is quite feasible to leave the arms free and allow the patient to read, and it is interesting to watch how the weights are lifted synchronously with the heart-beats, the body heaving rhythmically, while the patient reads away at a book or newspaper quite unconcernedly. In these cases the current closure is lengthened so that the moment of stimulation synchronizes with the heart-beat.

As regards the rate of reduction in weight, this will depend largely on the patient, the rate at which the duration of the treatment is increased, and the intensity of the treatment, both, of course, varying greatly with the personal factor. Rate of loss should not, as a rule, exceed 4 pounds per week, and will vary from $2\frac{1}{2}$ to $3\frac{1}{2}$ pounds usually.

It must be clearly understood that diet cannot be disregarded—indeed, it is an excellent principle for such patients in a measure to "feed on their hump." We all of us eat too much, generally speaking, and few people really understand how little is necessary not only to keep body and soul together, but in good health. The researches of Chittenden have enlightened us considerably in this respect.

Bergonié advises the free use of salads, with free draughts of tea (not too strong). Such a diet is calculated at least to fill the vacuum abhorred by Nature, and supply a certain amount of stimulation. Alternatively, a glass or two of light wine may be taken with several bananas, which, for all their reputation, are of low nutritive value. What is known as "a sinking sensation" is thus avoided. The diet generally advocated in cases of obesity is dealt with more fully in another section (p. 447).

Arterio-sclerosis.—The objective in using the treatment for this serious affection is to aid the cardio-vascular system,

take the strain off the heart, and aid the elimination of the causative factors of the disease, often products of defective metabolism. Care should be taken to use every electrode provided, leaving no part of the body out.

Cardiac Disease and Failing Compensation.—As would be concluded from previous statements, the heart is helped both directly and indirectly by the treatment, and its value should not be lost sight of in certain cases of morbus cordis. The rhythmical contraction of the muscles assists the *vis a tergo*, and the tissues are helped to rid themselves of excess of lymph. Any tendency to œdema is thus minimized.

SECTION VI

DIET IN THE TREATMENT OF DISEASE

CHAPTER I

GENERAL PRINCIPLES AND COMPOSITION OF FOOD

Dietetics consists in the study of the substances which serve for food, and the process of nutrition in health and disease.

All living creatures derive their nourishment from the vegetable kingdom, either directly, or indirectly by living upon animals which in their turn subsist on vegetables. Foods are the substances which are required for the nutrition and maintenance of the body and for the replacement of its wastes and losses.

In connection with the nutrition of a healthy man, we find that there is great variety in the nature and quality of the food substances used, as well as in the quantity consumed, by different individuals. Nevertheless, the three main elements in all descriptions of human sustenance are albumin, carbohydrates, and hydrocarbons, to which may be added water.

Vegetarians, such as Hindoos, derive most of their sustenance from the vegetable kingdom, while Gauchos, Esquimaux, and others, live almost entirely on animal food. The happy and safe medium lies between these two extremes, and the highest dietetic authorities, such as Voit, Pettenkofer, Chittenden, and Pavy, recommend a mixed diet of animal and vegetable food. In this connection Rudolf Virchow remarked: "Although the Esquimaux and Kirghiz show us that life and health can be maintained for many generations on an exclusively nitrogenous diet, and

other tribes such as the Hindoos live almost entirely on non-nitrogenous foods, yet history shows us that the highest attainments of the human race have emanated from nations who have lived and do live on mixed diets. A mixed diet taken partly from the animal and partly from the vegetable kingdom is the most suitable and digestible form of nourishment for mankind."

We derive the greatest amount of carbohydrates from the vegetable kingdom, while much albumin is derived from animal food. The proportion of vegetable to animal albumin in our food should be as 3 to 7 (Uffelman).

The larger portion of the food we consume is employed to generate the heat necessary for the maintenance of life, only a small portion going to make up for tissue waste. Food being thus intimately concerned in the production of heat, it is customary to speak of food in terms of its heat-producing capacity. A heat unit is the quantity of heat required to raise the temperature of 1 c.c. of water 1° C. The term commonly employed in calculating food energy, is "great heat unit" or calorie, by which is meant that quantity of heat energy which is required to raise the temperature of 1 kilogramme of water 1° C. Each kind of food is ultimately oxidized in the body to its end-products, and for the most part exhaled in the form of CO_2 gas; the more carbon atoms it contains, the more heat will it generate; thus 1 gramme of fat generates 9·3 calories, 1 gramme of carbohydrates 4·1, and 1 gramme of albumin 4·1 calories. The quantity of nourishment taken being ascertained, it is easy to determine the energy value, or number of calories introduced, by multiplying the different types of food-stuffs by the above figures. The amount of heat which it is requisite for the body to generate daily for its maintenance has been estimated at 2,500 units (Koenig).

Von Noorden gives the caloric value of food taken by the average working man as 40 units per kilogramme of body-weight per day, *when working*, and as 34 units *when resting*.

As stated above, a gramme of proteid in combustion produces 4·1 calories, 1 gramme of fat 9·3 calories, and

1 gramme of carbohydrate 4·1 calories. In ounces this takes the form—

1 ounce protein produces	116 calories.
1 ounce of carbohydrate produces	116 calories.
1 ounce of fat produces	263 calories.

With these data we can calculate the calories from various articles of food. For instance, if we take a sponge soufflé or pudding containing in each portion 0·305 ounce protein, 0·599 ounce fat, and 2·46 ounces carbohydrates, we see the multipliers for protein and starches are the same at 116, and for fats the multiplier is 263. Protein and carbohydrate may therefore be added together.

0·305	Take the fat as 0·6, and multiply 263
2·461	by that, and we get 157·8.
2·766	
117	
321·32	
157·8	Total calories equal 479.
479·12	If we wish to estimate for pounds, we have to multiply by 16.

Similarly, with simple articles of diet we can work out the calorie value very easily. For instance, a glass of whole milk has a calorie value of about 200; 100 grammes or a small teacup 72. Whey has a calorie value of less than one-third of this. An ounce of cream cheese has a calorie value of about 100; an ounce of butter 240; a raw egg about 50 calories, and so on.

By the following tables it is a simple matter to calculate approximately whether a given quantity of food constitutes an adequate diet or unit:

COMPOSITION OF COMMON ARTICLES OF FOOD (AFTER EINHORN).

I. Dairy Products.

	Albumin, per Cent.	*Fat, per Cent.*	*Carbo-hydrate, per Cent.*	*Calories, per Cent.*
Cow's milk ..	4·0 to 4·3	3·0 to 3·8	3·7	64·0
Cream	3·61	26·75	3·52	276·01
Butter	0·5	90·0	0·5	837·0
Whey	0·5	0·3	3·6	—
Buttermilk ..	3·0	1·3	3·0	3·67
Koumiss	3·35	2·07	3·0	33·99
Cream cheese ..	25·0	30·0	3·0	394·0
Cheese	33·0	9·0	5·0	240·0
Eggs	12·5	12·0	0·5	165·0

II. Meats and Game.

	Albumin, per Cent.	*Fat, per Cent.*	*Carbo-hydrate, per Cent.*	*Calories, per Cent.*
Beef (fat) ..	17·19	26·38	..	315·81
Beef (lean) ..	20·78	1·50	..	99·15
Veal (fat) ..	18·88	7·41	0·07	146·61
Veal (lean) ..	19·84	0·82	—	86·97
Mutton (very fat)	14·80	36·39	0·05	399·31
Mutton (leaner) ..	17·11	5·77	..	123·81
Pork (fat) ..	14·54	37·34	..	406·88
Pork (lean) ..	20·25	6·81	—	146·39
Ham	23·97	36·48	1·50	453·69
Sweetbread ..	22·0	0·4	—	93·92
Pulverized meat ..	64·5	5·24	2·28	322·53
Poultry	22·0	1·0	—	100·0
Spring chicken ..	18·49	9·34	1·20	167·59
Duck (wild) ..	22·65	3·11	2·33	131·36
Game	23·0	1·0	—	103·60
Hare	23·34	1·13	0·19	107·08
Venison	19·77	1·92	1·42	105·44

III. Cereals and Vegetables.

	Albumin, per Cent.	*Fat, per Cent.*	*Carbo-hydrate, per Cent.*	*Calories, per Cent.*
Sago	0·5	Traces	86·5	356·70
Wheat flour	8·5	1·25	73·0	345·78
Rye flour	10·0	2·0	69·0	342·50
Wheaten bread	6·0	0·75	52·0	245·0
Rye bread	4·5	1·0	46·0	216·0
Roll	6·82	0·77	43·72	213·87
Zwieback	9·5	1·0	75·0	356·0
Cauliflower	2·0 to 5·0	0·4	4·0	35·0
Carrots	1·04	0·21	6·74	33·85
Asparagus	2·0	0·3	2·5	21·0
Rice	5·5	1·5	76·0	348·10
Beans	19·5	2·0	52·0	311·75
Peas	19·5	2·0	54·0	319·95
Potatoes	1·5	—	20·0	88·0
Oatmeal	12·5	5·26	66·77	338·80
Barley-meal	8·31	0·81	75·19	323·0
Spinach	3·49	0·58	4·44	38·0
Pickles	1·02	0·09	0·95	

IV. Soups and Beverages.

	Albumin, per Cent.	*Fat, per Cent.*	*Carbo-hydrate, per Cent.*	*Calories, per Cent.*
Milk soup, with wheat flour	5·0	3·25	15·0	112·0
Meat broth (ordinary)	0·4	0·6	—	
Meat juice (pressed)	6·0 to 7·0	0·5	—	
Beef-tea	0·5	0·5		
Leube's meat solution	9·0 to 11·0 Albumin; 0·79 to 6·5 peptone			
Malt extract	8·0 to 10·0	—	55·0	258·30
Barley soup	1·5	1·0	11·0	60·96
Rice pap, with milk	8·8	3·5	28·6	182·61
Coffee	3·12	5·18	—	—
Tea	12·38	—		
Beer	0·5	5·25	0·3	
Porter	0·7	6·0	0·3	60·0

V. Fish.

	Albumin, per Cent.	*Fat, per Cent.*	*Carbo-hydrate, per Cent.*	*Calories, per Cent.*
Pike	18·5	0·5	0·75	83·57
Carp	20·61	1·09	—	94·64
Shellfish	17·09	9·34	—	156·93
Salmon	15·01	6·42	2·85	132·93
Oysters	4·95	0·37	—	24·0
Salt herring ..	19·5	17·0	0·5	—
Caviare	28·04	16·26	7·82	—

VI. Fruits.

	Free Acid, per Cent.	*Albumin, per Cent.*	*Fat, per Cent.*	*Carbo-hydrate, per Cent.*
Apples	0·82	0·36	—	7·22
Pears	0·20	0·36		3·54
Plums	1·50	0·40		4·68
Peaches	0·92	0·65		7·17
Grapes	0·79	0·59		1·96
Strawberries ..	0·93	0·54	0·45	1·01
Chestnuts ..		5·48	1·37	38·34
Sugar-cane ..				3·40
Honey		1·20		5·28

The average male adult consumes in the form of food about 120 grammes albumin, 90 grammes fats, 330 grammes carbohydrates, and 2,818 grammes water per day (Vierordt).

Eighty grammes of albumin per diem is said to be the lowest amount consistent with proper nutrition. Foodstuffs are built up of these four elements, and also contain small amounts of certain inorganic salts.

Animal Foods.

These comprise, besides the flesh (muscles) of the different mammals, birds, and fishes, several other portions of their bodies, as, for instance, various glands, the brain, lungs,

liver, etc. Oysters and lobsters also belong to this group. In most instances the digestibility of this group of foods corresponds to their richness in fat. The less fat they contain, the more digestible they are. Thus we have the following list of animal foods classified according to their digestibility:

	Fat per Cent.
Calf's sweetbread, veal, cod-fish, pike, oysters	0·4 to 1
Beef, hare, spring chicken, pigeon, partridge, carp ..	1 ,, 1½
Mutton, pork	5 ,, 7
Goose, caviare, herring, salmon, eel	Over 8

The digestibility of food is also greatly dependent on its quality and preparation. Young animals have soft and tender meat, whereas the flesh of old ones is tough. The different portions of an animal vary in their digestibility. The time that has passed since the killing of the animal is also of importance. Fresh meat which is yet in its rigid state is tough, and therefore very indigestible. In the preparation of the meat we must see that it is separated from all indigestible matter (fascia, tendons, cartilage). By pounding the meat the connective tissue surrounding the muscle fibre is torn. By chopping, scraping, or pulverizing the meat its digestibility is increased. All other methods of preparing meat only serve to improve its taste; for raw meat is more easily digested than that which has been boiled, broiled, or fried. The application of heat, however, diminishes the danger of infection, as many micro-organisms are destroyed by it.

Eggs are especially rich in albumin and fat. Soft-boiled eggs (three minutes in boiling water) are easiest to digest. Then come raw eggs and scrambled eggs, while hard-boiled eggs and omelette are difficult of digestion. Soft-boiled eggs remain in the stomach one and three-quarter hours, hard-boiled three hours.

Milk is intended as the sole food of young animals, and as such contains all the elements of a typical diet: (1) Albuminous substances in the form of casein and serum albumin; (2) fats in cream; (3) carbohydrates in the form of lactose or milk sugar; (4) salts, chiefly calcium phosphate; and (5) water. Milk does not stay in the stomach much

longer than plain water, and must therefore be considered very digestible.

Several articles of food are obtained from milk:

(*a*) *Cheese*, which is the casein precipitated with more or less fat, according as the cheese is made of skimmed milk (skim cheese), or fresh milk with its cream (Cheddar and Cheshire), or of fresh milk plus cream (Stilton and double Gloucester). The precipitated casein is allowed to ripen, by which process some of the albumin is split up, with formation of fat.

(*b*) *Cream* consists of the fatty globules encased in casein, and which, being of lowest specific gravity, rise to the surface.

(*c*) *Butter* is the fatty matter deprived of its casein envelope by the process of churning.

(*d*) *Buttermilk* is the fluid obtained from cream after butter has been formed. It is therefore very rich in nitrogen.

(*e*) *Whey* is the fluid which remains after the precipitation of casein. It contains sugar, salt, and a small quantity of albumin.

Vegetable Foods.

All these contain more or less carbohydrates, and the principal amount of carbohydrates of our diet is obtained from them.

1. **Foods Rich in Proteids.**—Leguminous foods (peas, beans, lentils, etc.) contain a nitrogenous substance called legumin (which is allied to albumin) in the proportion of 25 per cent. They form a chief source of the nitrogen of the food of vegetarians.

2. **Foods Rich in Carbohydrates.**—Cereals. Bread made from the ground grain of various so-called cereals, such as wheat, rye, maize, barley, rice, oats, etc., is the most direct form in which carbohydrate is supplied in an ordinary diet. Besides starch, bread contains gluten (a nitrogenous body) and a small amount of fat. White bread is easier to digest than brown. Various articles of food are made from flour—viz., spaghetti, macaroni, and biscuits.

The following table gives the approximate percentage composition of some of the principal food-stuffs:

PERCENTAGE COMPOSITION OF FOODS.

	Water.	*Proteids.*	*Starch.*	*Sugar.*	*Fat.*	*Salts.*
Bread ..	37	8	47	3	1	2
Wheat flour ..	15	11	66	4·2	2	1·7
Oatmeal ..	15	12·6	58	5·4	5·6	3
Rice	13	6	79	0·4	0·7	0·5
Peas (split) ..	15	23	55	2	2	2
Potatoes ..	75	2	18	3	0·2	0·7
Milk	86	4	—	5	3·8	0·8
Cheese ..	37	33	—	—	9	5
Lean beef ..	72	19	—	—	3	5
Fat beef ..	51	24	—	—	29	4
Mutton ..	72	18	—	—	5	5
Veal	63	16	—	—	16	4
White fish ..	78	18	—	—	3	1
Salmon	77	16	—	—	5·5	1·5
Eggs	74	14	—	—	12	1·5
Butter.. ..	15	—	—	—	83	2

Vitamins.

These substances have attracted a good deal of attention during the past few years, but as yet our knowledge of them is limited and somewhat vague. Whether they are of the nature of ferments or what is exactly their chemical nature we have no exact knowledge, but they are now looked upon as essential ingredients in the food of the human species. Scurvy was formerly attributed to a lack of potash salts in the food, but is much more probably due to lack of vitamin. Infantile scurvy is produced by using boiled or pasteurized milk without the accompaniment of fruit juices in some form, and we may safely conclude that heating of milk above a certain temperature destroys the essential vitamin.

There are three varieties which have been so far investigated:

Fat-soluble Vitamin A, which has been found essential for the growth of young animals. This has not yet been isolated, but its presence in certain fat foods has been clearly demonstrated. If it is absent from the food of young mammals the growth is checked, and there is but

a feeble resistance to bacterial invasion. This substance is absent from vegetable fats, and even some kinds of animal fats, and when present is easily destroyed by cooking.

Water-soluble Vitamin B, sometimes called antineuritic vitamin, has not yet been isolated either, but biological experiments prove that it is essential in the diet of animals. This was first discovered on Christmas Island (in the Pacific) during an outbreak of beri-beri, when it was shown that the epidemic was traceable to the use of polished rice, the polishing process removing the necessary vitamin. Animals from which this substance is withheld degenerate rapidly, owing to atrophy of their secretory organs. But recovery quickly takes place on food containing the vitamin being freely administered.

Water-soluble Vitamin C is sometimes known as anti-scorbutic vitamin. It is found in the juices of fruit and most uncooked vegetables. It is extremely unstable, and is usually destroyed by any of the ordinary cooking or preserving methods.

Recent research demonstrates the value of a small quantity of orange juice or grape juice added to the food of bottle-fed babies daily.

Probably we are only on the threshold of much more important discoveries in regard to these interesting bodies.

The Influence of Cooking on the Digestibility of Certain Foods.

Raw flesh has only one inconvenience—it sticks to the teeth—otherwise it is not at all unpleasant to taste. Seasoned with a little salt, it is easily digested, and must be at least as nourishing as in any other form. Man is a cooking animal, but broadly it may be stated that most forms of cooking actually lessen the digestibility of animal foods, rendering them in some cases tough and leathery, whilst they increase that of vegetable foods. It is a clinical fact that many patients can take raw or greatly underdone meats more easily than other forms of nourishment. This lessening of the digestibility of animal foods by cooking, regarded clinically, is in a measure made up for by ad-

vantages in their improved appearance and greater attractiveness, and by the new flavours developed in them serving to stimulate the secretion of gastric juice. They are also wholly or partly sterilized. The general effect of cooking on the structure of meat is to loosen its fibres by converting into gelatine the connective tissue which holds them together, and to remove fat; the chief effect on the chemical composition of meat is to diminish the amount of its water. That meat is rendered less digestible in proportion to the degree of cooking it undergoes is shown by the fact that $3\frac{1}{2}$ ounces of beef, taken raw, disappear completely from the stomach in two hours; if half-boiled, in two and a half hours; if wholly boiled, in three hours; if half-roasted, in three hours; and if wholly roasted, in four hours.

The effect of heat on the proteids of food is to coagulate them, which is effected at a temperature of about 77° C. If the temperature reached in cooking be beyond this, the value of the food is lessened by the hardening and shrinking of the proteid materials. The value of this fact, in its practical application to cooking, has long been recognized, though, unfortunately, it is commonly disregarded in practice. In boiling meat it should be plunged, for a few minutes only, in boiling water, sufficient just to cover it, when the superficial proteids are coagulated, the joint is "sealed," and its salts and extractives retained. The cooking should then be continued at a much lower temperature. With the exception of frying, it may be said generally that slow cooking is good cooking.

In roasting, the joint should be placed immediately close to the fire for a few minutes until it is "sealed," and then moved back, the drying of the continued roasting being prevented by persistent basting. In frying, the meat should be plunged suddenly into a deep pan of nearly boiling fat (or pure olive oil). The intense heat produces instantaneous coagulation of the proteids on the surface. So soon as the "sputtering" has ceased—in two or three minutes—the cooking is completed.

In the cooking of vegetables the moist heat swells up the starch grains and ruptures their envelopes, so that the starch grains form a paste or starch jelly. Unfortunately,

though cooking increases the digestibility of green vegetables, it still further reduces their already low nutritive value. Their chief value lies in their bulk and in their mineral salts.

The fats are less affected by heat than the proteids and carbohydrates. By high temperature some of the fat may undergo partial decomposition, by which free fatty acid is liberated. It is suggested that the greater digestibility of cold fat over hot is accounted for by the fatty acid reuniting with glycerine to form neutral fat on cooling.

Tea and Coffee.

These resemble one another in that they both owe their dietetic value and stimulating properties to the presence of alkaloids identical in character—viz., theine and caffeine. Tea is used in this country to such a vastly greater extent than coffee that a few words may be devoted to the consideration of it from the dietetic point of view.

Formerly most of our tea came from the Celestial Empire, but in the latter part of the last century Indian and Ceylon teas became so popular as largely to displace China tea in the public favour. During the past few years a change has occurred, and China tea is steadily gaining favour again. On physiological grounds this is a desideratum. Both Indian and Ceylon teas yield much more of the deleterious tannin in their infusion than good China tea. Further, the longer Indian tea is infused the more tannin is yielded. When infused for ten minutes Indian tea yields nearly twice as much tannin as China tea, and thus tea from India and Ceylon is much more prone to cause gastric disturbance and discomfort in sensitive persons than China tea.

The greatest ignorance prevails on this subject, and there are a very large number of people who have given up tea altogether, and who try to satisfy their wants with cocoa or milk and water, who, did they know of its value, would be perfectly able to take and enjoy good China tea.

Those who have become accustomed to the somewhat harsh and stronger flavour of Indian tea are inclined to complain that China tea is flavourless. This is far from the case. Good class China tea has a peculiarly fine flavour all its own, but the cheaper sorts do not make very pleasant beverages. The late Sir Andrew Clark and Dr. Samuel Fenwick were both strenuous advocates of good black China tea.

There is no doubt whatever that in this country an immense amount of ill-health and suffering is caused by the abuse of tea, which, so far as abstainers from alcohol are concerned, may be described as the national beverage. The harm done is, indeed, only second to that caused by alcohol. Abuse is both qualitative and quantitative. Some people drink tea to excess habitually, and when they begin to suffer from irritable nerves, sleeplessness, palpitation, and muscular tremors, they wonder "Why?" Among the working classes the cheaper kinds of tea, consisting largely of the mid-rib of the leaf, are used, and these contain a proportionately greater amount of tannin.

It is a remarkable fact that the British hostess among the upper middle classes will guilelessly offer the late caller who confidingly trusts in her hospitality a cup of a beverage which would temporarily inhibit the peptic processes of an ostrich, and which is wholly devoid of stimulating and refreshing properties.

The meal so popular among certain classes under the name of "high tea" is neither dinner nor breakfast, but is a physiological atrocity which should be strenuously avoided. The digestion of freshly cooked meats is greatly delayed by the presence of a strong infusion of tea. For persons with indifferent assimilative powers tea taken three hours after a meal is least likely to interfere with digestion; it is at once refreshing and an aid to that process, as it helps to empty the stomach. The five o'clock cup of tea which has of late years become so popular is therefore physiologically sound.

Alcoholic Beverages.

It would be hazardous in the extreme—even did space permit—to deal at any length with the vexed subject of alcohol, so much difference of opinion existing on the subject, not only among the laity, but the profession. It may be safely said that a very large proportion of the medical profession are total abstainers. This is largely due, doubtless, to the amount of suffering and wretchedness which they see in the pursuit of their profession owing to the abuse of alcohol by some of their patients.

The use of alcohol has the sanction of all the ages from the time of Noah to the present day. No reasonable person can deny that it was given us for our use. Whether we shall *use* it or not, and whether, if we use it, we are likely to *abuse* it, each individual must decide for himself. In spite of all that has been said by the ultra-total-abstinence fraternity, there can be no question that, dietetically considered, we have in alcohol a valuable stimulant.

Burney Yeo well says that it is at once a useful food, an agreeable stimulant, and a narcotic poison, according to the dose in which it is taken and the tissue reactions of the individual to whom it may be administered. Parkes' dictum that from 1 to 1½ ounces of absolute alcohol in the twenty-four hours is the maximum amount which a healthy man should take, "either in the form of wine, beer, or spirits," is regarded by the large majority of physicians as eminently sound.

In small quantities, taken with food, alcohol in most people improves the appetite and increases the enjoyment of food, and secondarily improves digestion. Many people take their food with greater relish and pleasure when accompanied by a glass of wine, and pleasure aids digestion. The sweeping statements of temperance fanatics as to the poisonous properties of alcohol are to be accepted with the greatest reserve. Gluttony is scarcely less objectionable than alcoholic intemperance. Unquestionably thousands

of people die annually as a direct or indirect result of the abuse of alcohol, but it is open to honest doubt whether as many individuals do not die prematurely from overeating as from overdrinking.

The percentage of alcohol contained in the usual intoxicating beverages is set out in the following table:

Rum	60 to 75	Burgundy	8 to 14
Whisky	50 ,, 60	Claret	8 ,, 12
Brandy (British)	50 ,, 60	Moselle	8 ,, 12
Brandy (French)	50 ,, 55	Rhine wines	7 ,, 16
Gin	48 ,, 60	Chablis	7 ,, 10
Port	15 ,, 18	Champagne	6 ,, 13
Marsala	15 ,, 21	Bitter ale	6 ,, 9
Sherry	14 ,, 18	Porter	4 ,, 7
Madeira	14 ,, 17	Cider	2 ,, 9
Sauterne	11 ,, 18	Beer	2 ,, 4
Hungarian wines	9 ,, 15	Ginger beer (brewed)	1 ,, 3

During the war the value of a tot of rum in the trenches was proved beyond doubt, and testified to strongly by medical and executive officers.

At the present moment America has gone dry—whether to remain so or not is a matter of conjecture—and Mr. "Pussyfoot" Johnson has been engaged in a prohibition campaign in this country. We must confess we resent such efforts, and they are hardly likely to find general acceptance with the nation.

Relative Digestibility of Foods.

Foods are described as easily digestible and indigestible, or difficult of digestion. These terms require some qualification. It is not sufficient merely to consider the time taken to complete *gastric* digestion of any food; its digestibility in the intestine must be taken into account, and the index of intestinal utilization is the amount of residue excreted by the bowels.

The approximate time taken for the gastric digestion of common articles of diet is shown in the following table:

TIME-TABLE FOR GASTRIC DIGESTION.

Articles of Diet.	*Time required for Digestion.*
Beef, boiled	3 hours.
,, roasted	3 to 4 hours.
,, smoked	4 ,, 5 ,,
Fish, boiled	1½ to 2½ hours.
Oysters (raw)	2 hours.
Lamb	2½ ,,
Mutton, boiled	3 ,,
,, roasted	3 to 3½ hours.
Milk	2 hours.
Sweetbread	2 ,,
Ham, boiled	2 to 3 hours.
Pork, roasted	5 hours.
Poultry, boiled or roasted	2½ to 4 hours.
Goose, roasted	4 ,, 5 ,,
Tripe	1 hour.
Veal (as prepared in the British Isles)	4½ hours.
Eggs, raw	2 ,,
,, fried or boiled hard	3 to 3½ hours.
Cheese	3 ,, 4 ,,
Apples	3 ,, 4 ,,
Cabbage	3½ ,, 4 ,,
Carrots	3 ,, 3½ ,,
Potatoes	2½ ,, 3½ ,,
Turnips	3½ ,, 4 ,,
Rice (if completely cooked)	1 ,, 2 ,,
Sago (if completely cooked)	1 ,, 2 ,,
Tapioca (if completely cooked)	1 ,, 2 ,,
Wheaten bread	3 ,, 4 ,,

An ordinary dinner is completely digested, leaving the stomach empty, in five to seven hours in the normal individual.

CHAPTER II

DIET IN HEALTH AND IN THE INDIVIDUAL

THE diet which we accustom ourselves to when in health should not always consist of the most easily digested substances; by so doing we may weaken our digestive system. While not going out of our way to select articles notoriously difficult of digestion, it is certainly not necessary or desirable that they should be avoided if the palate suggests them. A healthy diet is made up of a mixture in fair proportion of substances easy and difficult to digest, the former preponderating. Those foods which are usually found "digestible" and "indigestible" are indicated below.

Digestible.—Soups (clear); fish (*except* mackerel, salmon, crab, lobster, and eel); chicken, fowl, pigeon, game (not "high"), lamb, mutton; toasted or well-boiled bacon; tripe, sweetbread, cow-heel, calf's head; dry toast, plain rusks, stale bread; other farinaceous foods when in moderation, well-cooked potatoes, spinach, green vegetables generally in only small quantity; celery, French beans; fruit (without pips, core, or skin) in small quantity; milk, plain, or diluted with Vichy, soda, or seltzer water; tea (freshly made and not strong, and preferably China), coffee (not black), thin cocoa.

Difficult of Digestion.—New bread, wholemeal bread (usually), muffins, crumpets, buttered toast, pastry and sweets generally; hard, long-fibred meats, veal, pork, and beef; sauces, curries; all fried or recooked meats; fat or rich food such as duck, goose, and eels; green vegetables generally, save in small quantities for those whom they are known to suit; soups and broths, except in small quantity; foods generally which leave a large residue or which are in their nature irritating, such as seeds, kernels, rinds, skins,

and stalks; acid or unripe fruits; sour wines; tea with meat, or otherwise, unless of moderate strength and freshly infused.

In regard to individuality of stomachs, a well-known physician speaks as follows: "If asked by a patient, 'What shall I eat, doctor?' say, 'Eat what you like!' If he says, 'How much?' reply, 'As much as your appetite demands!' If he asks, 'When?' say, 'When you are hungry!'" Unfortunately, though this may be safe where the normal instinct exists, it is very often lost in dyspepsia and stomach disease, and such patients either eat too much and too often, or more frequently almost starve themselves.

No absolutely definite rules can be laid down as to the hours for eating. These will be influenced by so many different factors, such as the wishes of the individual, the size of the meals, and the exigencies of business. The more irregularity which the individual can tolerate without suffering or discomfort, the higher his standard of health.

So far as the substances included in the diet of any individual are concerned, in spite of the valuable work of Chittenden and other prominent dietitians and physiologists at the present day, the fact remains that the practical physician has no little difficulty in formulating any definition of the normal diet for a healthy man or woman. We cannot help realizing that among a number of individuals in perfect health, of approximately the same age and body-weight, and performing a similar amount of physical labour, the food necessary to sustain them and keep up physical vigour varies greatly in quantity and character. While the general principle holds good that given quantities of flesh food, bread-stuffs, milk, butter, sugar, and condiments —representing the essential proportions of proteids, carbohydrates, and hydrocarbons, etc., and their caloric value— are necessary for the average individual, yet the quantity of these consumed may be in inverse proportion to the size and stature of the individual; for we often find very small and very lean people consume much larger amounts of food than those of much ampler proportions.

Moreover, we find many men regard a beef-steak as the staff of life and foundation of physical energy, and look

with pitying contempt on the person who relies mainly for his sustenance on protein-containing vegetables and starchy dishes. Sir William Roberts used to say, "Our stomachs [meaning our digestive capacity and palates] are like our faces," and this very suggestive remark is only another way of saying one man's meat is another man's poison.

Physiological principles and facts only hold good to a certain degree, and it must be admitted that the dietaries of institutions such as prisons poor-houses and schools, based on stereotyped proportions of food-substances, are not wholly satisfactory in results nor satisfying to all the individuals concerned. In prisons, while some convicts get on fairly well as regards diet, a proportion are invariably ravenously hungry. Again, in schools some children are much happier and healthier when the amount of protein food is diminished and fats and starches increased, and *vice versa*.

It is useless ever to prescribe a dietary without taking into account the factor of personal idiosyncrasy, and Trousseau recognized this fact many years ago.

One of the most common metabolic idiosyncrasies is intolerance of purin-containing food-stuff, especially such articles as butcher's meat and strong tea and coffee.* While the majority of mankind are quite capable of consuming these articles with enjoyment, and, after abstracting a considerable amount of nourishment from them, eliminating the by-products of digestion, such as xanthin, hypoxanthin, adenine, guanine, and uric acid, without taking any hurt, not a few individuals suffer in no light degree from consuming them. The writer remembers a valued domestic servant once in his service who lived entirely on porridge, milk, cheese, bread and jam, butter, and weak tea or milk and water, and maintained a good standard of health, and in whom the slightest departure from this restricted dietary, such as the consumption of a small portion of fresh fish, resulted in a migraine attack and much discomfort and mental depression.

* Free and bound purins in common articles of diet, according to Dr. Walker Hall.

		Purins.
Fish:		
Cod	grains per pound	4·07
Salmon	,, ,,	8·15
Meat:		
Mutton	,, ,,	6·75
Beef	,, ,,	7·96–14·45
Chicken	,, ,,	9·06
Liver	,, ,,	19·26
Sweetbread	,, ,,	70·43
Eggs and Cheese, almost	,, ,,	0
Vegetables:		
White bread, rice	,, ,,	0
Cabbage, cauliflower, lettuce	,, ,,	0
Potatoes	,, ,,	0·14
Asparagus	,, ,,	1·5
Peas	,, ,,	3·54
Oatmeal	,, ,,	3·46
Beans	,, ,,	4·16
Beverages:		
Wines	grains per pint	0·0
Milk	,, ,,	0·0014
Beer	,, ,,	1·09–1·27
China tea (methyl purins)	grains per tea-cup	0·075
Ceylon tea ,, ,,	,, ,,	1·21
Coffee ,, ,,	,, ,,	1·7

Such cases are, indeed, very common, and though one may hardly be disposed to admit the soundness of all the pronouncements of Alexander Haig, the well-known writer on the subject of uric acid, still there is, unquestionably, a large proportion of truth in them, and many of our aches and pains and attacks of "the blues" must be due to a quantitatively faulty dietary, and the daily endeavour of a certain type of metabolic activity to deal with nutritive material which it is quite incapable of handling. It is perhaps too much to say that every individual suffering in this manner is unhealthy or physically abnormal. Few people are absolutely healthy if the highest standard and conception of health be taken. The pathologists who take a somewhat morbid view of this question often declare no one is in a condition of perfect health.

The maintenance of a condition of health and physical comfort, so far as the results of feeding are concerned, will depend in very many instances on a careful study of the individual as regards his digestive and metabolic capacities

or powers. There are many thousands of people in a condition of misery and physical incapacity at the present time from the constant occurrence of headaches and biliousness due to auto-intoxication, who may be entirely rehabilitated and literally set on their feet by the careful removal of purin-containing bodies from their daily dietary.

On the other hand, there are a very large number of people whose nutritional equilibrium and mental and physical activity can only be maintained by a diet containing a large proportion of animal food, who fall into ill-health on a starchy diet, and to whom milk puddings are as great a poison as black coffee and beef-steaks are to the man intolerant of purins. Such individuals often have a higher percentage of free HCl in the gastric juices than the normal physiological man; and, further, occupation and habits have much to do with the matter. Though the physiologist may dogmatically lay down to a grain the exact amount and proportion of food for the normal individual—according to whether his occupation is light, medium, or heavy labour—we are still compelled to recognize the fact that healthy people vary immensely in their metabolic activity. Whatever may be the caloric value of the food they consume, one *must* remember that it is transformed in very varying degrees and ways into kinetic energy by the chemical changes which it undergoes after absorption. There is much more rapid and complete combustion with some individuals than with others. We require to recognize clearly that different qualities and perhaps quantities of fuel are necessary to keep the various types and temperaments of the human machine in good working order; and the person whose metabolism requires more of one element than of another in his daily dietary can only be properly regarded as abnormal and diseased when his chemical processes are rendered faulty by his endeavouring to exist on stereotyped and conventional lines to which he is physiologically ill adapted.

Milner Fothergill, for instance, emphasized the value of sugar in the form of "toffee" for children, and the love for sweet things which young people almost invariably evince must be regarded as essentially normal and physiological. Their desire for heat-producing sugar, it is important to

note, most frequently coexists with an equally strong dislike of fat foods.

Parents, and those concerned in the upbringing and education of children, should realize that individual idiosyncrasy in diet exists with children as much as, if not to a greater extent than, with adults, and it certainly savours of cruelty, and is at any rate often very unwise, for reasons of discipline, to force a child to eat some article of diet for which it evinces a pronounced dislike.

How difficult it often is to settle on a food or milk mixture which absolutely suits an infant when the natural food fails any nurse of experience can tell; and it is often found that after ringing the changes on various patent foods, one of analytically poor food-value does best, where one of ideal synthetic composition has ignominiously failed. Metabolic idiosyncrasy evidently begins very early in life.

As old age creeps on, additional care in the arrangement of diet is needed, and almost invariably the amount of butcher's meat taken requires to be greatly reduced. In those with arterial thickening and hypertonus this is of special importance, and many lives are shortened by the tendency to "keep up the strength" with nutrition, often meaning highly stimulating, nitrogenous food. Lauder Brunton cited the case of an ancient millionaire whom he put on a pauper's diet, chiefly of toast and gruel, which was all his metabolism was equal to. On this he lived comfortably; but possibly resenting this restricted diet, he changed his physician, and being put on a more generous scale paid the penalty by an early demise.

The loss of teeth, from which the majority of old people suffer, is at any rate suggestive on the part of Nature, and possibly the substitutes willingly furnished by the prosthetic dental surgeon are not unmixed blessings if we put æsthetic considerations aside.

In old age small meals are best, but should consist of light, protein-free foods, with carefully chosen green vegetables (the coarser kinds such as cabbage and turnips being avoided). Flatulence is the curse of old age. *Pace* the total abstinence advocates, a small dose of well-matured spirit or good wine, which Fothergill described as "the milk of old age," is often of indisputable value.

Putting age and occupation aside, the season of the year and the climate does and must influence our appetite and capacity for utilizing food. Most people consume and really require a larger proportion of food in winter than in summer, and on a keen frosty day an amount of fat and oily matter can be consumed which would be offensive and nauseous in summer. The love of the Laplander for whale blubber and fat of all kinds is notorious, and with the need for hydrocarbons which his cold environment have occasioned, he has been endowed by Providence with the peculiar digestive activity for satisfactorily utilizing them. There appears to be no constant balance in the human species between the amount of animal and vegetable food necessary to sustain any individual. We recognize the average individual, but we are forced by clinical experience to admit that there are not a few types and modifications one way and the other, or our therapeutics will be futile in many cases. From the type of "the perfect man," physiologically, there are variants who, so long as they live on food composed of elements proportional to their needs, must be regarded as normal individuals. The fact that metabolic diseases are almost peculiar to man shows how common these variants from the ideal type are, and how frequently those with individual peculiarities suffer from attempting to accommodate themselves to the dietary and habits suitable to the average man. The proportion of animal *versus* vegetable food required by them differing from the average standard, their efforts to conform to this standard results in imperfect metabolism of either the protein or carbohydrate elements, and they fall into ill-health. The man who tries to convince his audience that a diet of nuts, or one free from fish and meat, is the only way to physiological salvation would probably hesitate to feed a sheep on beef-steak! And yet the anomaly is no more glaring than certain individuals attempting to maintain health and bodily vigour on a strictly vegetarian diet.

On the extent to which the physician is able by careful investigation on scientific lines to gauge the metabolic capabilities of individual patients, and properly guide them as to their dietetic habits, will largely depend his success in treating many forms of disease, and especially chronic disease.

CHAPTER III

DIET IN DISEASE

In disease the diet may vary considerably from the normal; it may have to be increased above the amount ordinarily required by the body, or it may have to be diminished as regards all its constituent elements; or one or more of these, either albumin, fat, or starches, may require to be lessened, or even entirely removed from the patient's dietary. We require, therefore, to consider reduced diet, increase of diet, and special diet.

On the integrity of the various digestive glands and their proper supply with blood, and on the normal condition of the nervous system, will depend the digestion and utilization of an amount of food sufficient to maintain health.

The digestive function may be affected in the following different ways: (1) Functional or organic disease of the special digestive organs; (2) any constitutional dyscrasia or toxæmia; (3) by the nervous system affecting reflexly or directly the mobility, secretion, or blood-supply of the special organ.

Further, diets may have to be modified owing to the functional or organic lesions disordering metabolism. The digestive and assimilative activity of the cells in the body tissues are altered, and metabolic activity lessened; this occurs in gout, diabetes, and obesity, and may follow various acute infective diseases.

Hutchison, who may be regarded as one of the greatest British dietetic authorities at the present day, lays down the following rules to be observed in drawing up any plan of dietetic treatment:

1. When prescribing a diet for a case of local disease, care

must be taken not to sacrifice the whole to the part. The organs are members one of another, and the patient's general nutrition must not be interfered with in the interests of any one of them. To avoid digestive discomfort this is too often done in cases of dyspepsia, and the general vitality of the patient lowered by too much abstemiousness.

2. No article of food must be forbidden without a good reason for doing so. Arbitrary restrictions must be avoided.

3. In acute disease one should recommend; in chronic disease forbid.

4. Before recommending any article, it is necessary to ascertain both whether the patient likes it and whether it agrees with him.

5. If any special article of food does not agree with the patient, it is better to reduce it than altogether cut it off from his dietary.

6. General changes of dietary should be made gradually.

The following are directions for the diet and general regulation of life in certain diseases, but are, of course, only general, and need careful modification for individual cases:

Gastric Disease and Insufficiency.

Formerly the diet for patients suffering from stomach trouble would come under the general heading of dyspepsia or indigestion—words which, until recently, were used as a cloak for want of accuracy in diagnosis.

During the past decade our knowledge of stomach disease has been greatly enriched, and the analysis of gastric contents and use of test meals have become almost as common as urinary analysis.

Putting aside actual malignant disease, we generally recognize at the present day the following gastric affections which require consideration from the dietetic point of view: Gastritis (acute and chronic), gastric neurasthenia and myasthenia, hyperchlorhydria and hypersecretion, gastric dilatation, and gastric ulcer.

In dealing with all forms of gastric disease, the problem facing the physician is to give sufficient food to allow for

the nutritive wants of the organism, and at the same time to adapt the food given, both in form and quantity, to the digestive capability of the patient.

Acute Gastritis.—At first the main indication is rest for the stomach, and entire abstinence from food must be enforced for about twenty-four hours, hot water being taken in sips at brief intervals. This lessens the nausea and washes out undigested débris from the stomach.

When the more acute symptoms have subsided, milk and lime-water or soda-water, chicken broth, toast-water, or barley-water, may be taken every two hours. A gradual return to normal diet is then permitted.

Chronic Gastritis.—Avoidance of all articles of an indigestible nature (see list, p. 424), and the taking of three well-cooked digestible meals and no more in the twenty-four hours, are indicated. There should be no "snacks" between meals. All highly seasoned food, sauces, and spices, must be studiously avoided.

While the patient is dressing in the morning, he should sip a glass of water, as hot as can be taken with comfort.

Hyperchlorhydria.—This condition may be associated with chlorosis or neurasthenia, and be purely functional in character, or it may be a symptom of a serious disease, hypersecretion, or gastro-succorrhœa continua chronica.

In either case the dietetic indications are much the same. Such patients are most comfortable with, and are best able to digest, a dietary which largely consists of proteid material. Starches make them uncomfortable, and are not digested. Swallowed saliva can scarcely be expected to exert any diastatic action when there is 0·5 per cent. free HCl in the gastric juice; nor, when the gastric contents pass on to the duodenum, can the pancreatic secretion act efficiently. It is argued by some physicians that by giving much proteid food we are merely exciting increased secretion of HCl, already excessive, and they plead for a modified starch diet. This view is not generally held, however, and personally, having carefully noted the effect of starch diet on cases of this nature which have come under my notice, I have invariably found the patients were made worse.

Proteids enter into chemical combination with the free

acid, and alleviate the pain from which such patients almost invariably suffer.

All ill-cooked and indigestible forms of meat, salt beef, and salt or smoked fish, should be absolutely avoided, but well-cooked boiled or roasted mutton or beef, fresh fish, milk, or raw eggs, should form the larger part of the food taken. A limited amount of altered starch food may be taken, such as Veda bread, and as improvement takes place toast, rusks, etc., may be added.

Strong tea or coffee, spices, pickles, and sauces, are entirely objectionable, and, indeed, the patient will usually voluntarily avoid them, as he knows too well the discomfort and pain which he invariably experiences after taking them. Milk and soda-water or whey may be taken as a beverage, and the meals should be limited to three in the day.

In **Gastric Myasthenia and Dilatation of the Stomach** the indications are practically the same. Perhaps the most important is the limitation of fluids. A wineglassful may be taken with each meal, and between meals fluid in quantities of a wineglassful or less at intervals of thirty to forty minutes. If it is not possible to give the patient a sufficient amount of fluid for the needs of the organism in this way, water may be administered *per rectum.*

Meals must be small in bulk, digestible, and nutritious in character. Probably the best arrangement is to give four small meals at intervals of four hours in the day.*

Gastric Ulcer.—In the first stage, when the ulcer is in an active condition, complete rest in bed, with rectal alimentation alone, is often needed.

After ten days a diet of peptonized or plain milk may be employed, and after this has continued for a couple of weeks more solid food is given. The milk may be thickened by the addition of cornflour or arrowroot, thin gruel or lentil food may be taken, and then chicken purées, creamed fish, and, finally, tender meats.

Gastric Neurasthenia.—It is impossible to lay down anything but the most general principles in the dietary to

* In gastric dilatation dependent on pyloric stricture, simple or malignant, dietetic treatment is mere temporizing. Such cases are surgical in their nature.

be prescribed for an ailment in which the symptoms and the personal factor differ so much. No two cases of gastric neurasthenia are alike. In some there is excess of hydrochloric acid, in others there is a condition approaching achylia gastrica. Further, the condition of the gastric secretion varies much from week to week, and even from day to day. The general line should be to *see that the patient takes a sufficiency of good, wholesome food, whether he suffers discomfort after or not.* Very often the difficulty in this class of case is to prevent the patient from leaving off article after article until he has cut down his diet far below the limits of health, and is actually perpetuating his disease by an over-restricted diet.

Constipation.

Constipation is often induced and perpetuated by a too exclusively nitrogenous diet, which is too easily digested, and leaves but little residue as the result of digestion. A normal amount of indigestible residue acts as a stimulus to the mucous membrane of the intestine. Further, if the supply of fluid to the blood be limited, less fluid is likely to be secreted by the intestinal glands, and the intestinal mucous membrane becomes drier. The freer the supply of water to the blood, the more fluid the intestinal secretions are likely to be.

Articles Allowed.—Clear soups; fish; meat of all kinds, except veal or pork; game, ham, bacon; bread (white, brown, or wholemeal); choose the coarser breads with bran or wholemeal when possible. The bread should be taken in fairly large quantities, and the kinds varied from time to time; it should never be new; the crust also should be eaten. Toast, with plenty of butter or dripping, is good. Gingerbread often acts well. Nuts are usually contra-indicated, but in some cases Brazil nuts or dry walnuts, well masticated, appear to help. Oatmeal, crushed oats with sugar and milk, or golden syrup, or old-fashioned treacle; cabbage, cauliflower, sprouts, French beans, endive, celery, spinach, salads with abundant oil; Spanish onions; apples, stewed or baked; figs, prunes, dates, Normandy

pippins or pears, stewed; oranges, grapes, bananas, strawberries, gooseberries, currants, etc.; jam, marmalade, preserved fruits; hot or cold water; tea, always freshly made and never strong or taken with meat; coffee, thin cocoa; beer; waters, such as Vichy, Vals, St. Galmier, Condal, Pullna, and Rubinat.

Articles Forbidden.—New bread and pastry; eggs, except in moderation and lightly cooked (best when "scrambled"); peas, broad beans, new potatoes, rice, tapioca, etc. (unless with fruit or jam or honey); nuts of all kinds; milk (except in small quantities or mixed with Vichy or similar water); sherry.

General Directions.—1. The patient must be urged to take a full quantity of fluid—for an adult at least $2\frac{1}{2}$ to 3 pints daily. Many women suffering from constipation will be found to take only 1 to $1\frac{1}{4}$ pints daily; their constipation often depends upon this alone, and yields when a sufficient quantity of liquid is taken.

2. This fluid may well include a tumblerful of water, cold or hot, immediately on getting out of bed in the morning, and a tumblerful of hot water at bedtime. Where hot water, with or without a saline aperient, is ordered to be taken in the morning, the effect is often enhanced if it be slowly sipped while dressing.

3. No meat to be taken with tea; fruit or jam, honey or treacle with farinaceous foods (*e.g.*, blancmange or rice,) and order every night or early morning a full quantity of such fruit as stewed figs, baked apples, Normandy pippins, bananas, etc.

4. The body should be warmly clothed to avoid the skin getting chilled, and the feet kept warm and dry by thick boots with a cork or asbestos sock.

5. Tepid or cold sponging, followed by sharp friction with a rough towel and flesh-glove, daily, to secure a vigorous action of the skin.

6. Abdominal massage for ten minutes before rising every morning. This (which can readily be done by the patient), followed by the cold or hot water on rising, is often sufficient to produce a speedy evacuation.

Diarrhœa.

A general dietetic rule that applies to all cases of diarrhœa is to avoid all foods that leave much undigested residue behind which would tend to irritate the surface of the intestinal mucous membrane.

The patient may be allowed cold milk (boiled for preference), plain or peptonized, alone or with lime-water or barley-water; koumiss whey, white wine whey, albumin-water, rice-water; soups (without vegetables) thickened with arrowroot, rice, sago, or tapioca, and with or without brandy in addition; raw meat, pounded meat; sweetbread, tripe; calf's-foot jelly; eggs, lightly boiled or poached, or beaten up with brandy; plain biscuits, rusks; gruels, brandy or port wine, whisky and water, or whisky and a natural mineral water such as Apollinaris or seltzer.

Articles Forbidden.—Rich soups and meat essences; green vegetables, acid fruits, nuts, potatoes; brown bread, wholemeal bread; all hard foods, or hard meats, or rich, fat meats, especially veal and pork; beef tea, malt tea, malt liquors and wines.

General Directions.—1. Warmth and absolute rest in bed.

2. Warm clothing, especially for the abdomen.

3. The food should be given in small quantities frequently; it is usually better given cold.

4. During convalescence the food should be increased cautiously.

Gout.

Views as to the etiology of gout have of late years undergone a marked, almost revolutionary change, and the part played by uric acid and its salts is now regarded as a comparatively unimportant one. While at the present moment there is complete absence of unanimity as to the actual cause, there is general agreement that derangements of the gastro-intestinal tract constitute an important factor in the development of acute and chronic gout. It is therefore of essential importance to secure a healthy condition of the gastro-intestinal mucous membrane, and a gouty

patient can always diminish the frequency and severity of his attacks by a carefully arranged diet, by insuring a daily evacuation of the bowels, and by taking sufficient active exercise.

No single diet can be regarded as suitable for all gouty patients, but as a general principle in many cases the following articles are allowed: All fresh vegetables freely (with exceptions named); fish (with exceptions named); eggs in moderation, lightly boiled or poached; meats (those of the lighter and whiter kinds) in great moderation; rice, sago, and tapioca; fresh ripe fruits (with exceptions named); soups; toast or stale bread; potatoes, salads, celery, and green vegetables (with exceptions named); milk, skimmed, diluted with Apollinaris, Vals, Vichy, or seltzer water; lime-juice freely diluted; China tea, freshly infused and not strong; coffee, which should be taken only in moderation, and not at night; cocoa; tobacco in moderation.

In small quantities only : Bread, plain biscuits, potatoes, asparagus, tomatoes, haricot beans, broad beans, peas, and lentils; eggs; whisky or brandy (not to exceed 2 ounces in the twelve hours), unsweetened gin, claret, or hock, freely diluted; butter and cheese.

Articles Forbidden.—Fats and rich foods, recooked foods, sauces, rich gravies and made dishes; the harder or richer meats, beef, pork, or veal (as prepared in the British Isles); smoked, dried, or pickled fish, pork, or other meat; pastry, jellies, sugar; meat essences and strong soups; rhubarb, gooseberries, currants, strawberries (except in moderation); oysters, mullet, mackerel, salmon, herring, eel, lobster, crab; duck, goose, hare; mushrooms, truffles, pickles and spices; preserved fruits; ale, porter, stout, port (usually), champagne (nearly always), Burgundy, sherry, Madeira, and all liqueurs.

General Directions. — 1. Moderation in animal food, liberality in vegetables. The proportion of these must be adapted to each case.

2. Abundant fluid, of which plain hot water (for preference slowly sipped), night and morning, may form an important part.

3. Regular exercise. A gouty patient should walk daily

not less than from three to four miles, unless there be reason to the contrary in the individual case. Gout, however, is not uncommon in those who take exercise freely, and the degree and kind of exercise must be carefully prescribed in each case.

4. Warm baths, tepid or cold sponging, skin friction, massage, and Turkish baths.

5. Free action of the skin, kidneys, and bowels, regular hours, warm clothing, and the avoidance of fatigue are essential.

6. Not less than seven nor more than eight hours' sleep. The patient should go to bed early and get up early.

Renal Disease and Albuminuria.

No rigid system of diet can be formulated for all kidney diseases, nor for all stages of any form of nephritis. In determining the diet attention must be directed for the most part to the actual condition of the urine, but in addition to that other factors, such as the patient's general nutrition, the presence of dropsy, the condition of the cardiovascular system, and the presence or absence of uræmic symptoms, must be taken into consideration.

When dropsy and uræmia are present in a marked degree, the ordering of the diet must be based on the principle of reducing the work thrown upon the kidneys as far as possible, and this is especially the method to be adopted in acute renal disease. Indeed, in acute nephritis it is often advisable to withhold all food for a few days; in subacute and commencing chronic cases, to allow only milk until the albumin percentage is low. In chronic disease of the granular or "mixed" type, the indications are to administer food which is readily assimilable, will not tax the digestion, and will furnish the smallest amount of nitrogenous waste calling for elimination by the damaged kidneys.

The patient should have a diet something as follows: Soups thickened with arrowroot, vermicelli, rice, or barley. Fish, fowl, pigeon, game, butter, cream, eggs in moderation: green vegetables, celery, onions, salads, mushrooms, artichokes, cauliflower, turnips; milk (plain or with alkaline

water or peptonized), skim milk, whey, koumiss, milk diluted with rice-water or barley-water; farinaceous foods, such as bread (stale), toast, rice, tapioca, vermicelli, arrow-root, sago, macaroni; tea, cocoa, and coffee in moderation; soda-water, seltzer, Vichy, Vals, Ems, Salutaris, plain water (unless hard); in certain cases a little old whisky, freely diluted, or red wine in small quantity and freely diluted with water or mineral water.

Forbidden Articles.—Sugar, ices, pastry, and sweet foods generally; new bread, butcher's meats, especially of the brown kinds; beef tea, meat essence and jellies, strong soups; recooked meats, stews, hashes; highly spiced food, pickles and sauces; rich foods, such as hare, duck, and goose; potatoes, peas, and broad beans, except in great moderation; cheese; every form of alcohol (with the occasional exception of those previously named).

General Directions.—1. A quiet life without worry or excitement.

2. A warm, dry, equable climate.

3. Woollen clothing next the skin night and day all the year round.

4. Hot-air, vapour, or Turkish baths; daily tepid sponging with skin friction. Avoid hot and cold baths, but warm baths may be taken.

5. Regular daily exercise, always stopping short of fatigue.

6. A free, regular action of the skin, kidneys, and bowels should be maintained.

Diet in Anæmia.

The diet must often be light and easily assimilable at first, as the appetite is poor in many cases and digestion disturbed. Milk and milk puddings; concentrated nutritious soups and purées; fish, chicken, tripe (if not distasteful to the patient), and sweetbread; lightly cooked eggs in various forms; grilled bacon. Game, meat (scraped, pounded, or minced) may be added if well borne. Care must be taken to avoid too fluid a diet, as this may hamper the digestion; but, on the other hand, these patients are usually consti-

pated, and should take in the day not less than 3 pints in small quantities, either in the form of fluid foods or water. A glass of good Burgundy at dinner or sound port, while bitter ale or stout may be taken at lunch if well borne.

Fruit, ripe and fresh or cooked, in all forms is good, and such vegetables as spinach, stewed celery, Brussels sprouts, and artichokes, can be given safely. The following articles are better left alone: pork, veal, recooked meats vinegar, pickles, and all highly spiced foods.

The iron percentage in various forms of foods is important to bear in mind, and the following table given by Bunge is of interest (the figures are percentages in 100 grammes of the article mentioned):

	Per Cent.		*Per Cent.*
Spinach	35·9	Beans	7 to 8·3
Oatmeal	13·2	Lentils	8 to 9
Apples	13·2	Strawberries	8·9
Fish (oysters) ..	Up to 84	Peas	6·6
Beef	4·5 to 16	Potatoes	Up to 6
Eggs	5·7	Rice	1·3

Such a table is suggestive in formulating a dietary.

Medicinal waters, such as Flitwick, Trefriw, and Levico (arsenical), may be helpful. Trefriw is the most potent chalybeate water in Great Britain, and is sent out in bottles from the wells for home use.

As regards general directions, care must be taken to avoid exercise which overtires, and rest should always be taken before meals. The open-air life and sunshine, when obtainable, is always to be advocated.

Arterio-sclerosis.

The unfortunate thing as regards dieting in this condition is that we are in a measure merely locking the door after the steed is gone! In many cases that come into one's hands the rise in pressure has existed for some years, the patient's arteries are thickened, kidneys contracting, and the heart hypertrophied to some extent. The physician thus cannot cure the condition, but only ameliorate it so as to add to the comfort of the patient's daily existence and possibly prolong his life.

The rise in blood-pressure, apart from that due to kidney trouble after scarlatina, such as we more commonly meet with in the young, is due to a daily practice of overeating, and perhaps overdrinking as well. There is excess of food, positive or relative. The fat man must be reduced, not only because he is eating too much, and so causes his obesity, but he cannot take brisk exercise while excessively stout. Not all arterio-sclerotics are obese, however, by any means.

If the blood-pressure is excessively high, the food must be sharply reduced to half or even less, the patient being kept in bed, perhaps, for six weeks while undergoing this painful ordeal. Alcohol is a contributory agent to the trouble, and will perhaps need complete elimination from the dietary, while the amount of tobacco allowed will require restriction, the physician being guided by the character of the pulse and presence of arrhythmia.

Nitrogenous food it is, above all, most important to cut down, and purin-containing articles of diet, such as rich soups, sweetbreads, hare, strong coffee.

In many cases it is best to cut out butcher's meat entirely, and substitute a fish, egg, and milk diet, with occasional poultry, rabbit, pigeon, or game when in season. Cheese can be taken freely if digested, and the sour-milk cheese of the type of "St. Ivel" is most wholesome and easily digested.

Fruit can be used freely as a rule—stewed fruit at lunch and dinner, with an apple in the morning; while some patients like and do well on a quantity of nuts. The main indications, therefore, are a drastic reduction in the amount of food taken, often the amount of liquor taken, and a substitution of a milk, egg, fruit, and vegetable diet as varied as possible.

Unfortunately, patients vary, and their statements of how much they take cannot be relied on. Many subjects of this disease are greedy, if not gluttonous; they are arterio-sclerotic because of this, though this is by no means a universal rule. In such cases the physician is often helpless unless the patient be treated in a nursing home. If a wife act as a sort of food sentry, it does not tend to

family peace. Some patients are more easily dealt with, and do not consider the remedy worse than the disease.

In older patients with well-established arterial changes, granular kidneys (probably), and a blood-pressure of 220 to 240, we are often constrained to be complaisant; it is too late, and drastic treatment not only makes the patient miserable, but may be dangerous. He has got "tuned up" to the pressure, and it may be kindest not to tell him his risk.

Chronic Cardiac Disease.

Owing to the intimate anatomical relation between the stomach and the heart, care is always needed as regards the regulation of diet in cardiac patients. The overloading of a stomach at a social gathering has more than once been the last straw which broke down a struggling heart and brought the patient's life to an abrupt and even tragic conclusion. Gaseous distension of the stomach merely causes great distress and embarrassment in subjects who have no organic heart disease, but with a chronic cardiac patient is always dangerous and to be avoided.

Thus, the question of quantity of food is as important as the quality almost; the meals must be smaller than in the average healthy man, and should be dry in character, little fluid being taken at the time. Fluids can be taken in the early morning and before retiring, and in smaller quantities between meals.

Aerated waters are to be avoided, and also anything likely to ferment, such as excess of sugar and jam, unripe and overripe fruit.

Rusks, toast, zwieback, and crackers are preferable to bread, and new bread is always bad to take. Milk puddings properly cooked, with rice grains, etc., burst, are excellent, and in the way of vegetables marrows, stewed celery, spinach, mealy potatoes, and well-cooked cauliflower can be taken.

Grilled and roast meat is always better than anything stewed. Fish, such as salmon, herring (fresh or cured), and all shell-fish, are best avoided.

A moderate amount of old spirit, brandy or whisky, does

good, helping both the appetite and the digestion. China tea is preferable to Indian tea, and after-dinner coffee is, on the whole, omitted.

In failing compensation, G. Balfour laid down the following rules:

1. At least five hours between each meal.
2. No solid food between meals.
3. The solid meal of the day should be taken at 1 p.m.
4. Meals should be as solid as possible, not more than 5 ounces of fluid being taken.

Tobacco must be used with caution, if at all, but complete withholding of it may really embitter many men's existence, and this has to be borne in mind.

Diet in Chronic Rheumatism.

It is necessary to avoid excess of sugars and jams and animal food, both of which tend to lead to abnormal fermentations and putrefaction, with resultant auto-toxæmia. Excess of fruit is not desirable either, though a moderate consumption of apples is devoid of harm. In the cider counties rheumatism is by no means a common complaint. Meat may be taken once a day in one form or another, but many people do best on a milk, egg, and vegetable diet. It is well that the food does not consist of too many mixtures, and anything solid should be well masticated. Attention must be given to the bowels, and all constipation avoided.

Different patients have different digestive disabilities, and the question of individual idiosyncrasies has to be borne in mind.

Of fruits, strawberries do not, as a rule, agree with people with an arthritic diathesis, nor does rhubarb.

But further than that, anything which actually upsets the digestion will aggravate rheumatism, so that quality as well as quantity have to be considered.

Many rheumatic subjects—and this is specially so with women—drink too little fluid, which induces constipation. By such patients more fluid than the average should be taken during the day, beginning with hot water in the morning. Some people do better with cold water, but it

may seem heavy on the stomach, and, if cold, is more digestible when aerated. There is no special virtue in lithia water either in gout or rheumatism, in spite of a certain reputation among the laity, but it is at any rate harmless.

Diet in Rheumatoid Arthritis.

Many patients suffer from gastro-intestinal troubles as well as their joints. The one may be causative of the other condition, or aggravate it. That is to say, a primary bad digestion may help to induce the joint trouble, or the latter disability, by restricting exercise, may upset the patient's digestion and further aggravate the joint trouble—a vicious circle, in short. The joint condition will not improve until the digestion is dealt with. Food must be carefully selected, well masticated, and given at regular intervals. Fluids should generally be taken towards the end of meals, and a short rest both before and after.

One of the most fatal mistakes in such cases is to unduly restrict the meat element in the diet. There is quite a widespread idea that meat is bad for such patients, which has no solid foundation on fact if it be given in reasonable quantities only. Chalmers Watson points out that, if pushed, it may do harm by aggravating pre-existent intestinal putrefaction, and this is certainly a point of importance. But sub-nutrition and thin blood is commonly co-existent, and has to be ruthlessly combated if the patient is to recover. The urine can be watched, and excess of urea, uric acid, and indican looked for, along with the aromatic sulphates.

If this be observed, a return must be made to a milk, egg, and starch diet. But, generally speaking, poultry, game (except hare), lamb, beef, mutton, and fat ham, with white fish of any sort; the heavier fish may be difficult for some of these patients to digest.

No restrictions should be placed on fresh green vegetables or fruits, if they agree. As regards beverages, tea, coffee, and cocoa are unobjectionable in reasonable strength and quantity, and a good red wine at dinner, with a glass of sound ale at lunch, is worthy of all commendation.

Diet in Mucous Colitis.

While special care and precautions are highly necessary in the treatment of mucous colitis if good results are to be obtained, the expectations of immediate benefit from this factor of the treatment must not be put too high by the patient. There are two separate lines of dietetic treatment which can be adopted as alternatives—the coarse cellulose diet advised by von Noorden, the irritating effect of which on the intestine is minimized by the addition of fat in various forms. Other physicians, on the contrary, have urged the employment of a diet leaving a scanty residue—one of a bland, unirritating nature, in short.

As a matter of fact, both diets are useful in their place, but every case requires to be judged on its own merits. Modifications can be made to suit different individuals. Some patients do with a moderate cellulose diet, except that intolerable flatulence is caused by it. Patients who are ill-nourished and continue to lose weight require a simple diet of milk, fat, and carbohydrates, the cellulose elements being added by degrees. Their utilization of the food is promoted by the employment of general massage. In severe cases, especially when the patient's nervous system is markedly below par, isolation in a nursing home may be called for, and a dietary somewhat as follows may be employed:

At 7 a.m.: Half a pint of cream mixture.

8 a.m.: Half a pint of slightly alkaline mineral water, effervescing.

9 a.m.: Half a pint of cocoa with cream, 2 ounces of bread, 2 ounces of butter, and some finely shredded marmalade.

11.30 a.m.: Half a pint of purée or milk soup, 3 ounces of bread, and an ounce of butter.

1 p.m. Lunch: Some shredded or scraped meat, 2 ounces of bread, riced potatoes, some spinach finely minced, a baked apple, stewed fruit (seedless), and cream.

4 p.m.: Half a pint of milk-cream mixture.

7 p.m.: Dinner as lunch, but a little more bread or toast and butter may be taken.
9.30 p.m.: Half a pint of milk-cream mixture again.

This milk-cream mixture is made up of equal parts of milk and cream, and a teaspoonful of sugar to each pint. With the present great shortage of milk and cream there may at times be some difficulty in procuring it.

The various milk soups and purées should be judiciously flavoured from time to time with various vegetables. The meat taken is scraped from a steak with a blunt knife, or the steak finely minced and then pounded in a mortar. It is mixed with a little white of egg and milk, placed in a china basin, and boiled in a "Gourmet" water-bath or double-jacketed pan for about five minutes, being well stirred the while.

The cellulose elements in the diet are gradually increased —white bread is reduced, and brown or Graham bread substituted. Wholemeal biscuits are given for variety, and as the cellulose element is increased, so the fatty elements in the diet are increased in proportion.

When this diet is tolerated for some time, as the mucus in the stools diminishes, a gradual return is made to ordinary diet, including the coarser green vegetables.

Alcohol is to be avoided in mucous colitis, practically doing harm in whatever form employed; this is a point De Langenhagen emphasizes.

In Harrogate a special form of biscuits of high protein value, known as Caledonian biscuits, are frequently ordered. We have personally given fish-cream and the finer kinds of fish with acceptance to the patient and no apparent harm, but it is customary in Harrogate to rule fish out of the diet, generally speaking.

Obesity.

Unless the patient is habitually excessive in the amount eaten, or unless the obesity be so marked in degree as to cause actual physical disability or disease, it is best not to prescribe any very restricted dietetic treatment. Some individuals, though extremely stout, enjoy excellent health,

and a revolutionary alteration in their habits should not be lightly undertaken.

Changes in quantity and quality must be gradually effected. It is unsafe to put any patient on a very restricted diet suddenly. A weekly loss in weight of 3 pounds should not be exceeded. Many diets have been prescribed by many authorities, only differing in details. They all resemble one another in the reduced calorie value, the aim being to make up deficiency in this respect from the fat of the patient's tissues.

Generally speaking, something like the following is suitable:

Articles Allowed.—Clear soups in small quantity only; broths, not thickened or containing such ingredients as rice or barley; fish and lean meat (with exceptions named); eggs; fruit; green vegetables; stale bread, toast, rusks, and biscuits in great moderation, or gluten and almond bread or biscuits; butter; water (hot or cold); milk (skimmed), diluted with Vichy, Vals, seltzer, or other natural water; tea or coffee, with saccharin instead of sugar; natural mineral waters; claret, hock, Chablis, whisky or brandy, in moderation.

Articles Forbidden.—Thick soups; eels, mackerel, salmon, herrings, sardines with oil; pork, duck, goose; rice, tapioca, macaroni, oatmeal, sago, arrowroot; potatoes, peas, broad beans, parsnips, carrots, beetroot; pastry and sweets; sugar, starchy cocoas; cream and milk, except in great moderation; ale, porter, stout, port, champagne, and liqueurs.

General Directions.—1. An active life, with full occupation, short hours of sleep, and the most vigorous exercise compatible with the physical condition. Cycling, horse exercise, and fencing, are especially valuable; but the form and amount of exercise must be carefully adapted to each case.

2. Free action of the bowels and skin, with regular Turkish baths.

3. The entire quantity of liquid taken, of all kinds, should be moderate.

(*See also the "Salisbury" and "Banting" Systems.*)

CHAPTER IV

THE BANTING SYSTEM

In 1863 Mr. William Banting published a letter on "Corpulence," addressed to the public. It was "respectfully dedicated to the Public simply and entirely from an earnest desire to confer a benefit" on his fellow-creatures. It was issued at the price of sixpence, any profit yielded being devoted to the Printers' Pension Society. The author spoke pathetically of the "parasite of obesity," and told how he had just emerged from a very long probation in this affliction, and how he hoped the publication of this letter would lead to the same comfort and happiness he now felt under the extraordinary change. He recorded that he was sixty-six years of age, 5 feet 5 inches in stature, and in 1862 weighed 202 pounds. He was of active and regular habits, and (as he believed) did not indulge in anything to excess. There was no hereditary tendency to corpulence. He had adopted increased bodily exertion, and especially rowing, with, unfortunately, development of a prodigious appetite, which he was in some degree constrained to indulge. He tried fresh air and bathing and Turkish baths (ninety); and took "gallons of physic," "adopted riding on horseback, the waters and climate of Leamington, Cheltenham, and Harrogate, and spared no trouble or expense in consultations with the best authorities in the land." His last state, however, was worse than his first, for he records that he could not stoop to tie his shoe and had to go downstairs slowly backwards. He took yet further advice from a gentleman, who left him in a worse plight than ever to go for his annual holiday. "This," said Mr. Banting, "was the greatest possible blessing to me." He found another adviser, who dieted him, with the result that in about a year he recorded that he had not

felt better in health for the past twenty-six years; that he had suffered no inconvenience; that he was reduced 13 inches in bulk and 50 pounds in weight; that he was cured of umbilical rupture; that he had sight and hearing surprising at his age; and that his other bodily ailments had become mere matters of history. His personal appearance improved, he bore the stamp of good health, ate and drank and slept well, had no indigestion, left off using boot-hooks, and could stoop with ease and freedom. He suffered no longer from faintness, and left off his knee bandages.

The author of this quaint historical, clinical record states that his diet before treatment was bread and milk for breakfast, or a pint of tea with plenty of milk, sugar, and buttered toast; meat, beer, much bread, and pastry for dinner; the meal of tea similar to that of breakfast, and generally a fruit tart or bread and milk for supper. The diet ordered for him by his adviser, Mr. Harvey, of Soho Square (whom he consulted for deafness), who learned it from M. Bernard's Paris Lectures for Diabetes, and himself initiated it for obesity, forms the Banting cure as detailed below. As Mr. Banting himself said, the remedy might have been as old as the hills, but the application of it was of very recent date. The forbidden foods were bread, butter, milk, sugar, and potatoes. The author's own view was that saccharine matter is the "great moving cause of fatty corpulence."

Breakfast (8 to 9 a.m.): 4 or 5 ounces of beef, mutton, kidneys, broiled fish, or bacon; cold meat of any sort except pork; a large cup of tea (without milk or sugar), a little biscuit, or 1 ounce of dry toast.

Dinner (1 to 2 p.m.): 5 or 6 ounces of any fish except salmon, any meat except pork, any vegetable except potato, and 1 ounce of dried toast, fruit out of a pudding, any kind of poultry or game, and two or three glasses of good claret, sherry, or Madeira—champagne, port, or beer, being strictly forbidden.

Tea (5 to 6 p.m.): 2 or 3 ounces of fruit, a rusk or two, or a cup of tea without milk or sugar.

Supper (9 p.m.): 3 to 4 ounces of fish similar to dinner, with a glass or two of claret.

Nightcap (when inclination directs): A tumblerful of grog (gin, whisky, or brandy, without sugar), or a glass of claret or sherry.

On the whole the Banting system is sound in principle, has the advantage of some simplicity, and forms the groundwork of most obesity diets of to-day. It is unduly liberal, however, compared with many dietaries we have to prescribe if patients are to lose weight. On it a man of moderate weight would not probably become obese, but many people would keep their weight on it. There is also a risk with certain subjects of so much nitrogenous food being a strain on the kidneys.

The Salisbury Diet System.

The system was first introduced by a Mr. J. H. Salisbury, of New York, who in 1887 published a book entitled "Brief Summary of the So-called Salisbury Plan for the Treatment by Alimentation of the Various Diseases caused by Unhealthy and Indiscreet Feeding." The principles laid down in the treatise have been widely adopted in the treatment of various morbid conditions.

Salisbury's system was intended to influence disease due to improper feeding (obesity, for example), all arterio-sclerotic conditions, and those associated with excessive development either of the connective or fatty tissues, and various forms of dyspepsia. The essentials are the taking of hot water and a diet consisting of about two-thirds of lean meat and one-third of vegetables. The water should be taken as hot as the patient can bear it: 1 pint in the morning on rising, 1 pint an hour and a half before each meal and half an hour before bedtime. It should be slowly sipped, so that the time taken in its consumption is between five and fifteen minutes, and uncomfortable distension is avoided.

If there be thirst between meals, the patient may take hot water plain, or lemon or toast water, or "crust coffee." At meals 5 to 8 ounces of clear tea or coffee are allowed. The main food should be the muscle pulp of beef; broiled or roasted lamb or mutton; broiled beef-steak or roast beef;

oysters raw or broiled or roasted in the shell; broiled or boiled fish; chicken or game and turkey broiled or roasted; salt and pepper; Worcester sauce and chutney in moderation; celery may be taken as a vegetable. All meats should be fairly well cooked and taken regularly, either alone or in company of others taking the same diet.

It is claimed that under this system adipose tissue will rapidly disappear, the loss of weight being at the rate of 10 pounds to 30 pounds per month, according to the degree of fatness, the strictness of the diet, the amount of exercise, and the mental condition of the patient. If the loss of weight be too rapid, so that the skin hangs in folds, such food as bread, toast, rice, cracked wheat, and potatoes may be added. The loss of 10 pounds to 15 pounds a month is advocated as the ideal rate of weight reduction. When the desired weight and bulk have been reached, the fat-forming foods should be taken in such proportion as may suffice to maintain them, usually 2 parts of meat to 1 part of vegetable bulk. It is stated that the relish for beef may become so great that from 1 to 2 pounds may be taken at each meal.

The body should be washed twice daily with soap and water, and afterwards rubbed with equal parts of glycerine and water. Regular exercise, short of fatigue, should be taken; or, where this is impossible, the body should be well rubbed from head to foot for from ten to twenty minutes three times daily. Flannel or silk should be worn next the skin, and the body be kept comfortably warm. All methods calculated to maintain health should be observed.

The above diet will cause most people to lose weight quickly. Before advising anyone to rigidly adhere to it, however, it would be well to exclude the existence of chronic granular nephritis. A dietary with so great a proportion of nitrogenous food will tax severely any but the healthiest kidneys.

The Milk Cure.

The milk cure has been systematically applied to all manner of ailments, such as the following: Dropsies of all kinds, cardiac, renal, and hepatic; obstinate intestinal neuralgias; incorrigible dyspepsia with grave disturbances

of nutrition; chronic colitis; hepatic disorders, such as hyperæmia; simple hypertrophy of the liver and fatty liver; asthma, emphysema; neurasthenic, hysterical, and hypochondriacal states associated with serious disturbances of nutrition; and especially in disorders of nutrition dependent on latent catarrhs of the stomach and intestines, and also on obesity. Karell of Petrograd held the view that the methodical use of the milk cure produced its effect as a regulator of nutrition, and he maintains that it is highly beneficial not only in cases already enumerated, but also in rheumatic and gouty affections, organic disease of the heart, advanced renal degeneration, and in arterio-sclerosis.

The milk used should be *well skimmed*—as creamless as possible—and it should be obtained fresh twice daily from country-fed cows. At first the doses should be small. Weir Mitchell prescribes 4 ounces every two hours, and as the doses are increased the interval between them is lengthened to three hours; he also allows a glass during the night, to which a little lime-water is added to keep it sweet.

At the commencement 3 ounces to 6 ounces are given three or four times a day, and these doses are scrupulously adhered to, and no other food is taken. The doses should be taken at equal intervals, and drunk slowly in small mouthfuls, so that the saliva may mix with it. Taken in this way, it will be readily digested, whereas drunk *ad libitum* it would cause indigestion. In winter the milk should be warmed by standing the glass in hot water; in summer it should be taken of the temperature of the apartment. It should not be boiled, except in rare cases of diarrhœa.

If the milk is well digested, as indicated by small solid motions, the dose is slowly increased. The first week is the difficult one to get over; during the second week $3\frac{1}{2}$ pints a day may be taken at fixed intervals—viz., 8 a.m., 12 noon, 4 p.m., and 8 p.m. These hours may be changed, but the intervals must be maintained.

When there is great objection on the part of the patient to its use, with nausea or disgust, Weir Mitchell allows it to be flavoured with a little tea, coffee, caramel, or salt.

He also advises in certain cases that the general diet should be displaced slowly until the exclusive milk diet can be tolerated. When it provokes acidity, some alkali may be added, such as lime-water or Vichy water; or it may be scalded with 25 per cent. boiling water and a little carbonate of soda and salt added; or a little barley or rice water may be mixed with the milk to prevent firm clotting. The patients seldom complain of either hunger or thirst, but if those who are seriously ill attempt to take, instead of the four cups of skimmed milk, four large glasses of milk direct from the cow, they will certainly not be able to digest it, and the treatment will be discredited. In obstinate sickness and diarrhœa Karell has obtained the best results from these small doses, and he cites one such case in which he gave only four tablespoonfuls of skimmed milk three times a day. No doubt, in a case of this kind, the almost absolute rest of the digestive organs which such treatment affords is an important agent in the cure.

Constipation may be regarded as a natural consequence, and a sign that the milk is absorbed. It may be remedied by a simple enema of water, or by a small dose of castor oil or rhubarb; and if obstinate, a little coffee should be mixed with the morning milk, or some stewed prunes or a baked apple may be eaten at 4 p.m.

Flatulence is, as a rule, completely relieved by this diet; if, however, any flatulence or diarrhœa should be complained of, it is owing either to imperfect skimming of the milk or to its being taken in too large a quantity. Thirst may be relieved by simple water or seltzer water.

If during the second or third week there should be a great desire for solid food, a little stale bread with salt, or a small portion of salted herring, is permitted; and once a day a little soup made with milk and thickened with groats. After five or six weeks some modification is admissible; milk, however, should still be taken three times a day.

It is almost unnecessary to point out the importance of combining rest with this treatment at the commencement, for the patients lose weight at first and feel weak on account of the small amount taken; after long use, however, they increase in weight. For the first week or two it also causes

sleepiness. The tongue becomes covered with a white, thick fur, and the patients complain of an unpleasant, sweetish taste in the mouth on waking. The stools are of a yellowish colour, and have a peculiar odour. There is usually a large flow of urine, which may exceed in quantity the fluid ingested, and so lead to the removal of dropsical effusions. Weir Mitchell has also observed that uric acid disappears almost entirely from the urine, which assumes "a singular greenish tint," and when hot nitric acid is poured upon it, it no longer gives the usual mahogany tint at the plane of contact; and it would seem that during a diet of milk "the ordinary pigments of the urine disappear or are singularly modified." The substances which give rise to the ordinary fæcal odours also disappear.

The changes here pointed out are remarkable indications of the vast alterations in assimilation and the destruction of tissues which seem to take place under this peculiar diet. The duration of the cure is ordinarily about six weeks, and at the end of this period the quantity of milk should gradually be reduced and solid food slowly introduced in the place of milk meals, beginning with raw scraped beef and stale bread. But for several months the diet should consist largely of milk. It is, of course, well known by all practising physicians that quite a number of people cannot take such a diet, partly because they are subjects of the "indigestion of fluids," with gastric atony and the like, or cannot digest it because it upsets their liver, gives them a severe headache and filthy tongue. In such cases there is little use pushing the cure. A certain amount may be digested, however, if blended with cocoa or coffee in the form of weak *café au lait*.

The Whey Cure.

In many of the Swiss and Continental spas, and especially in those with saline springs where chronic catarrh of the respiratory organs is treated, such as Ems, Reichenhall, and Ischl, the whey cure is employed. The whey is taken warm, either alone or with mineral water in definite quantities at set times. Many physicians regard this practice as in all respects equal to the use of skimmed milk, and in

some cases preferable, as certain people find the casein of milk indigestible. About 20 ounces a day are taken.

Irritable laryngeal coughs are relieved, and a favourable influence is exercised over catarrhal conditions of the respiratory organs generally.

It has been found useful in certain forms of dyspepsia, intestinal catarrhs, and in chronic phthisis. Whey acts as a diuretic, especially in combination with saline mineral waters, and recent observations have shown that lactose possesses distinctly diuretic properties.

It has been recommended in the treatment of chronic Bright's disease. The "whey cure" is not an exclusive diet cure, but it is usual to strictly limit the amount of animal food taken and to augment the fruit and vegetables. It adds, however, to the diet a certain amount of milk salts and milk sugar. There are various methods of preparing whey, but the following is a good one: Take ½ pint of fresh milk heated to 60-65° F., and one and a half teaspoonfuls of wine of pepsin or Fairchild's essence of pepsin, and stir just enough to mix. Stand the mixture in a warm place until coagulation occurs. Next beat up the curd until finely divided, and then strain. Whey contains in solution the sugar and salts of milk, and also holds in suspension a considerable portion of fat and casein which passes through the strainer.

At the health resorts mentioned whey is prepared from the milk of the sheep and the goat, as well as from cow's milk.

The Koumiss Cure.

Koumiss, or the fermented milk of the steppe mares, is used as a food and as an intoxicating beverage by all the nomadic tribes of the south-eastern steppe country of Russia.

The treatment in the steppes lasts two or three months, and is often renewed the following summer.

Annaeff's establishment for the koumiss cure stands in a park on a hill on the banks of the Volga, 3 versts distant from Samara. It is provided with a library, theatre, and other comforts. The koumiss is prepared by a Tartar

family in the sight of the patients, and with due regard to cleanliness. In its manufacture the milk-sugar is converted into alcohol, carbonic acid, and lactic acid. The casein is in a state of fine subdivision most easy of digestion.

TABLE OF THE RELATIVE COMPOSITION OF SEVERAL STRENGTHS OF KOUMISS (STANGE).

		Koumiss—Duration of Fermentation.			
	Mare's Milk.	6 *Hours.*	18 *Hours.*	30 *Hours.*	4 *Days.*
Carbonic acid ..	—	3·8	6·0	7·0	11·0
Alcohol	—	18·5	19·5	30·0	30·0
Lactic acid ..	—	3·9	5·6	6·4	6·4
Milk-sugar ..	51	18·8	16·3	—	—
Albumin ..	23	22·5	22·6	20·0	16·0
Fat	19	18·9	20·0	19·0	19·0
Salts	5	4·5	4·0	4·0	4·0

An analysis of koumiss made in Moscow after two days' fermentation gave: Alcohol, 1·65 per cent.; fats, 2·05; milk-sugar, 2·20; lactic acid, 1·15; finely divided casein, 1·12; salts, 0·28; carbonic acid, 9·70. Dr Stange came to the conclusion that "favourable results" can only be obtained from the koumiss cure on the steppes, seeing that, besides the employment of genuine koumiss, a hot and dry climate is absolutely necessary." He found it specially beneficial in respiratory catarrhal conditions, and also catarrh of the gastric mucous membrane. It was found of service also in the early stages of phthisis, as well as in conditions of general malnutrition, such as anæmia, malarial cachexia, and scrofula.

Artificial koumiss is prepared in England by the Aylesbury and other dairy companies. But undoubtedly the best koumiss is to be obtained on the steppes, and the best results follow its use. Prior to the war, at any rate, institutions existed both at Moscow and Petrograd where koumiss from steppe mares could be obtained. A factor of importance in the cure, however, is the delightful summer climate

of the steppes, which seems specially suited for pulmonary cases; the winters are severe, on the other hand. The people who are normally resident there seem to have completely mastered the art of the making of koumiss, though its composition is by no means stable. It is rich in milk-sugar and comparatively poor in casein and fats.

Large quantities of koumiss can be easily digested, and it has been observed to exert a diuretic or diaphoretic action according to whether the external temperature is high or low; weight is usually gained, and many cases of phthisis have been reported cured in the Samara and Orenberg steppes.

A special breed of mares is used—light-coloured, unbroken beasts, pasturing in the steppes near mountain ranges, where they get running water and salt beds. They should be able to bathe frequently, and must not have hay or oats.

There are two kinds of koumiss made—one light-coloured and slightly fermented, the other strong and highly fermented.

The patients are made to rise early and take a glass of koumiss every half-hour, except the two hours preceding supper and dinner. Meats and fats form the chief part of the ordinary food; sweets, fruits, and salads are avoided, as well as coffee, ices, and spirits. Lime-water is used to arrest the diarrhœa koumiss so often causes. At first a few glasses only are taken, so as to accustom the patient to the cure; although the diarrhœa has to be guarded against, most patients digest it well; it relieves constipation, moreover, and acts as a diuretic. The patients gain in weight and show signs of increased blood-formation. Doubtless the cure is helped by ample exercise in the open air.

Good koumiss is a milky-looking, frothy fluid with an agreeable, slightly acid taste, containing about 1 per cent. of alcohol and lactic acid. Its ease of digestion is partly attributed to the stimulating effects of the alcohol on the digestive secretions; the amount is too small to cause any intoxication, however. It usually makes the patient feel drowsy and languorous, but in some subjects acts as an aphrodisiac.

The Grape Cure.

The grape cure is another dietetic cure of which a brief account must be given here. The nutritive value of grapes is not great; they contain, however, much sugar as well as potash salts. They are an agreeable form of food, and afford a therapeutic measure at our disposal between nutritive substances on the one hand and medicinal substances on the other. Much of the benefit referred to this cure may be doubtless more properly attributed to the climatic advantages of such localities as Meran and Montreux, where the cure is taken. The effect of the cure is aided by a supporting diet of nutritive character. Pulmonary patients should not take more than an average of 2 pounds of grapes a day, beginning with a pound; other patients should not exceed 4 pounds. In cases of gastric catarrh 3 pounds a day may be eaten, the diet at the same time being carefully regulated. Constipation, with hepatic congestion and "abdominal plethora," may be benefited by 3 pounds to 4 pounds daily; and in these cases the dose may exceptionally be increased to 5 or 6 pounds. The laxative influence of 4 pounds to 6 pounds of grapes eaten daily has been found beneficial in hæmorrhoidal affections, and in cardiac diseases with a tendency to visceral congestion and venous engorgement, in hyperæmia of the liver, and in chronic constipation.

The tendency of the renal and hepatic concretions is often advantageously modified by this cure. It is best to begin with ½ pound of grapes in the morning fasting (or an hour or two after a light breakfast if they disagree when taken fasting), and another ½ pound at 5 p.m. After two or three days a third ½ pound should be taken between 11 and 12 noon. Little by little the dose is increased to about a pound each time. In other cases which bear the cure well larger quantities may be prescribed. In some cases of dyspepsia a bunch or two at dessert may be substituted for the midday dose.

The aperient effect may not be manifest at first, but it usually shows itself after a few days.

Figs and pears are also permitted with the cure at Meran, in order to diminish the repugnance of one kind of fruit alone.

Some irritation of the gums is apt to be excited during the cure; this may be relieved by rinsing the mouth with cold water to which a little bicarbonate of soda is added. It has also been recommended that the patient should, while eating the grapes, take from time to time a small piece of fine white bread to remove any portion of the fruit adhering to the teeth.

Towards the end of the cure, which lasts from four to six weeks, the quantity of grapes should be gradually diminished.

The main composition of grapes, according to Koenig, is—Water, 78·17 per cent.; sugar, 14·36; free acid, 0·79; nitrogenous extractives, 1·96; stones and woody fibre, 3·60; total ash, 0·53. The ash consists chiefly of potash salts, together with salts of lime and magnesia.

The grape cure may prove beneficial, and is prescribed with success in those cases of "abdominal plethora" associated with a deposition of much superfluous fat; much of this fat may be removed if the laxative influence of the grapes is aided by a spare diet in which the fats and carbohydrates are strictly limited. It cannot be credited with any real curative influence in phthisis, but it appears to be useful in cases of chronic bronchial catarrh and emphysema, and has been found beneficial in cases of gastric and intestinal catarrh in anæmic persons, in vesical catarrh, in gouty concretions, and in cases of malarial cachexia.

The Soured Milk Diet.

We largely owe the popularization of this diet and method of treatment to the late M. Metchnikoff, of the Pasteur Institute, Paris. Nine years ago it became a craze, and everybody was taking it. It has, of course, been a staple article of diet in the Near East, especially in Bulgaria, for hundreds of years, and is there known under the name of "yorghourt."

In 1910 the writer prescribed it very largely, and had it

made in considerable quantities daily by means of an electric oven. It is now much less in vogue, as the whole thing was overdone, and through the much-advertised illness of a well-known actress, due to taking a "bad brew," so far as society went, the thing for the time received a death-blow.

This is no new experience with new forms of treatment, and in no way detracts from the real value of the soured milk. It is probably one of the most effective, if not the most effective, method of combating intestinal toxæmia along with constipation. The main agent concerned is the bacillus of Massol, which generates free lactic acid and combats the formation of butyric acid and putrefaction generally.

This has been clearly demonstrated by Herter of New York and other workers. Metchnikoff popularized and placed on the market a tabloid preparation known as "Lactobacilline," which was stated to contain the live germs and was taken either with milk or eau sucrée. This started the growth of the germ in the intestine, and it continued to multiply long after the administration ceased. Undoubtedly the best way to produce this effect, however, was, under proper precautions, to prepare milk from a pure strain of the *B. Massol* obtained from a reliable laboratory, and day by day to continue the souring of fresh milk by means of subcultures. This was our practice. The milk is pleasant to take, with a sharp taste, rather refreshing than otherwise, and ameliorated by the addition of sugar and some cinnamon powder.

Ordinary buttermilk is taken by some people for the same reason, but is devoid of fat and of comparatively low nutritive value. When milk is soured, the casein is rendered soluble to a large extent, while the phosphate of lime has its solubility increased. The curds thus cause no digestive upset if taken in reasonable quantity.

In certain conditions remarkable results have been obtained: for instance, in children with severe gastro-intestinal catarrh; in chronic gastric catarrh and intestinal putrefaction with pultaceous stools in adults, also in gout, rheumatism, and chronic nephritis.

It is of special value where the proteins are not digested adequately, but is practically valueless in carbohydrate fermentation. While at present rather lost sight of, it is not a treatment which should be forgotten. From most of the large dairy companies the soured milk can be regularly obtained in sealed jars, and the home preparation is not by any means a difficult matter.

Dried Milks and Casein Foods.

We can hardly leave the subject of milk cures without reference to these valuable dietetic articles, which have come into vogue of late years, and been so useful in dealing with patients whom milk upsets and makes bilious. They are sold under various names—the original Sanatogen (first made in Germany), Ceregen, Bynogen, and other fancy names.

They are unquestionably of real merit as extra food, and in certain subjects we have again and again noted the steady increase in weight and nerve tone when they were used.

Some neurasthenics have a tendency to constant looseness of the bowels, and this is very often checked by the administration of these foods. On the other hand, those folk who suffer from "dura ilia" find their ailment aggravated, and if prescribed they must be accompanied by some laxatives or malt.

CHAPTER V

DIABETES

THE principle to be kept in view in ordering the food of a diabetic patient is that by mainly protein and fat diet the excretion of sugar in slight cases can be entirely suspended, and in severe cases kept at a very low figure.

So far as is practicable, therefore, fats and albuminates should form the sole food of the patient. The more severe the nature of the case, the more rigid the adherence to this rule should be.

It will be found essential, however, to have some regard to the feelings and wishes of the patient. Some will almost invariably resent being placed on a diet composed exclusively of fats and meat, and apart from their wishes such a diet may be actually injurious to them when used exclusively. Certainly, present opinion is that sudden withdrawal of all starches tends to bring about the always dreaded condition of acetonæmia. There is an inclination just now to allow the patient a limited amount of bread-stuff, toasted preferably, and this is well, for the most difficult problem in the dieting of diabetics has ever been to find some substitute for bread which is at once palatable, easily prepared, and inexpensive.

A dietary somewhat as follows may be regarded as in agreement with the views of most physicians at the present time:

Ceteris paribus, patients are allowed—All clear soups and broths; fish of all kinds (except cod's liver), including shell-fish (with plain melted butter only): meats of all kinds; eggs in all forms; cream, butter, cheese, gluten, bran and almond breads and biscuits; greens, spinach, broccoli, turnip-tops, watercress, mushrooms, mustard

and cress, cucumber, lettuce, tomatoes, celery (sparingly), endive; French beans, cauliflower, and asparagus (the green part), all in great moderation; strawberries, gooseberries, raspberries, currants, peaches, and nectarines, in very small quantity, and occasionally only; oranges and lemons; nuts of all kinds, except chestnuts; pickles, olives, vinegar, oil jelly (sweetened, if preferred, with "saxin" or lævulose); whipped cream, custards; koumiss, milk in great moderation; tea, coffee, cocoa (nibs); claret, hock, dry Sauterne, Chablis, Burgundy, brandy, and whisky; soda-water, Apollinaris, seltzer, Contrexéville, Vichy, Vals, or St. Galmier waters; saccharine or lævulose as a sweetening agent. Any alcohol should be ordered in great moderation.

Articles Forbidden.—Sugar and starch in any form, bread and biscuits (unless in small quantity when specially directed); rice, tapioca, sago, vermicelli, arrowroot, cornflour, oatmeal; potatoes, peas, broad beans, parsnips, beetroot, carrot, Spanish onions; pastry and puddings of all kinds; fruits of all kinds, fresh or preserved, except those named (in moderation only); milk (except in small quantity), ale, stout, porter, port, champagne, liqueurs, and cider. No flour should be used in the frying of food for diabetic patients. Of breads specially made, Bruisson Jeune is one of the best.

General Directions.—1. Regular daily exercise is extremely important, but fatigue should be avoided.

2. Flannel clothing next the skin always, most carefully guarding against "catching cold."

3. A calm, equable, regular life, with good hours, and without worry or excitement or overwork.

4. Regular action of the skin should be encouraged by tepid sponging, followed by skin friction, by warm bathing, massage, and Turkish baths.

It is usually the better practice to gradually lessen the carbohydrate foods until the sugar has disappeared, and afterwards to tentatively replace them, noting the effect of each addition as a guide.

The Allen Treatment of Diabetes.

This is a modification of the *Guelpa* cure.

For the first two days the patient is put upon a diet containing a minimum of fat. The following is an average day's régime as regards diet:

Breakfast: 12 ounces of coffee, 2 ounces milk, an egg, and 4 ounces of raw lettuce.

Lunch: 8 ounces of clear soup, 29 ounces of lean meat, and 8 ounces of cooked cabbage.

Tea: 12 ounces of tea, with an ounce of milk, and a few radishes.

Dinner: 8 ounces of clear soup, 2 ounces of sole, turbot, or plaice, an egg, 8 ounces of stewed celery, and an orange.

At the end of these two days the patient remains in bed, and is nursed as if recovering from a severe illness. He is protected from worries, any mental exertion, and the visits of friends. He is allowed to get up for a morning bath and to go to the lavatory. Metabolism is thus reduced to a minimum, and a condition of almost metabolic stasis brought about, so that the patient loses a minimum of weight during the period of very restricted diet.

The patient is also under the immediate control and observation of the physician or his assistants. He may drink as much water, plain or aerated, as he wishes, but it must all be measured before consumption. Care must be taken to insure an action of the bowels once a day at least. An effervescing saline—seidlitz powder, a few ounces of Apenta, or the like—usually secures this, but if need be castor oil is given as well, or recourse had to a Higginson syringe.

For a period of twenty-four hours after the urine has become free of sugar the patient's diet is carefully restricted to weak tea, coffee, or clear beef tea. Every care should be taken to have these nicely prepared and served hot, so as to be palatable to the patients. Diabetics are naturally short in the temper, and "do not suffer fools gladly." Unpleasantness is thus avoided, and the patient spared petty irritation, which the boredom and severity of the treatment render him specially liable to resent.

Cups and glasses of known capacity should be used, so as to avoid cooling off fluids by specially measuring them.

Alcohol is not necessarily avoided; indeed, if the patient has been in the habit of "taking his whack," he may be indulged to the extent of two or three glasses a day—of 59 per cent. under proof.

For the beef tea, Liebig's extract, Mosquera beef jelly, or similar preparations, are handy.

At least 8 ounces of weak tea, coffee, or beef tea, are given four times daily. It is useless to specify "at dinner," etc., as there is no meal in the ordinary sense.

The urine passed in the twenty-four hours is collected, beginning at 8 a.m. For detecting sugar Leyton recommends the following (Benedict's) test: Get a solution of copper sulphate, 18 grammes; sodium citrate, 299 grammes; and water to 1,000 c.c. Boil 10 c.c. of this for two minutes with 20 drops of the urine, and allow the mixture to cool. If cloudiness or any sort of a precipitate develop within a quarter of an hour after cooling, sugar may be regarded as present.

As a corroborative test we use an alkaline solution of sodium nitrophenyl propiolate, which, when boiled with the urine containing sugar, forms indigo.

The essential factor to realize is that the diet as above must be continued until the sugar has been absent from the urine for twenty-four hours. It is manifest that treatment of this kind cannot be properly carried out except in a hospital, nursing home, or institution of some sort.

After the fasting period described above and the disappearance of the sugar, food is given in increasing amounts, with a view to establishing the tolerance of the patient for carbohydrate, proteid, and fat. The starch given is in such a form that it is freely mixed with cellulose and thus slowly absorbed. Bread is unsuitable for this purpose, but use is made of asparagus, French beans, and sea-kale. When cooked, these contain less than 3 per cent. of starch, and a commencement is made with 250 grammes, which means 5 grammes of pure starch. To make the treatment tolerable, it is necessary to add after the third day a little fat and a gradually increasing amount of proteid.

By the tenth day the patient is taking something like the following, *ceteris paribus :*

Breakfast: ½ pint of coffee and 1 ounce of thin cream, an egg, 1 ounce of cooked bacon fat, and 7 ounces of raw lettuce.

Lunch: 1½ ounces of cooked lean meat, ½ ounce of fat, 3½ ounces of cooked sea-kale or beans, 1½ ounces of boiled potatoes.

Tea: ½ pint of weak tea, 1 ounce of thin cream, an egg, and ¾ ounce of boiled potatoes.

Dinner: 8 ounces of consommé, 1 egg, 4 ounces of cooked cabbage, and 2½ ounces of cooked sea-kale or French beans.

Calorie value=952.

The response of each patient to such diet will vary greatly, sugar frequently returning in some degree as the carbohydrate factor is increased or too much proteid taken. If sugar returns after the fifteenth day, while the carbohydrate is being increased, but proteid has been kept constant, it is an indication that the carbohydrate limit has been passed. A further period of fasting is indicated. If the sugar returns before the sixth day, both skill and patience are needed both on the doctor's and the patient's part. Patients must be warned not to worry about their weight, and the carbohydrate may have to be reduced to below 10 grammes, but an adequate amount of proteid given.

The optimum diet is arranged when it is found the patient keeps free of sugar in his urine, and keeps his weight, or even starts to gain a few ounces a week; rapid gains must not be looked for.

In the main the results obtained are much better than by any previous method of treatment. Leyton states that at the London Hospital, of 66 diabetics, 39 were treated by this method, and 29 left sugar-free and taking a diet of about 2,000 calories. Of the 27 treated by other methods, 3 only left sugar-free.

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